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WITH INDEXES

Supplement 80

FEBRUARY 1977

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 80

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in January 1977 in

- *Scientific and Technical Aerospace Reports (STAR)*
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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued

This supplement to *Aeronautical Engineering -- A Special Bibliography* (NASA SP-7037) lists 277 reports, journal articles, and other documents originally announced in January 1977 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

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Three indexes -- subject, personal author, and contract number -- are included

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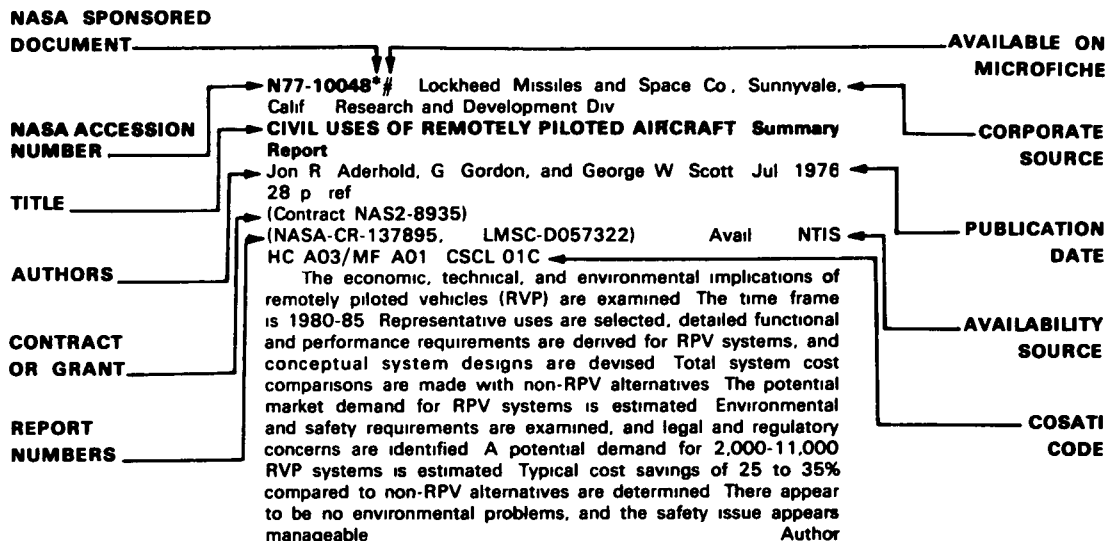
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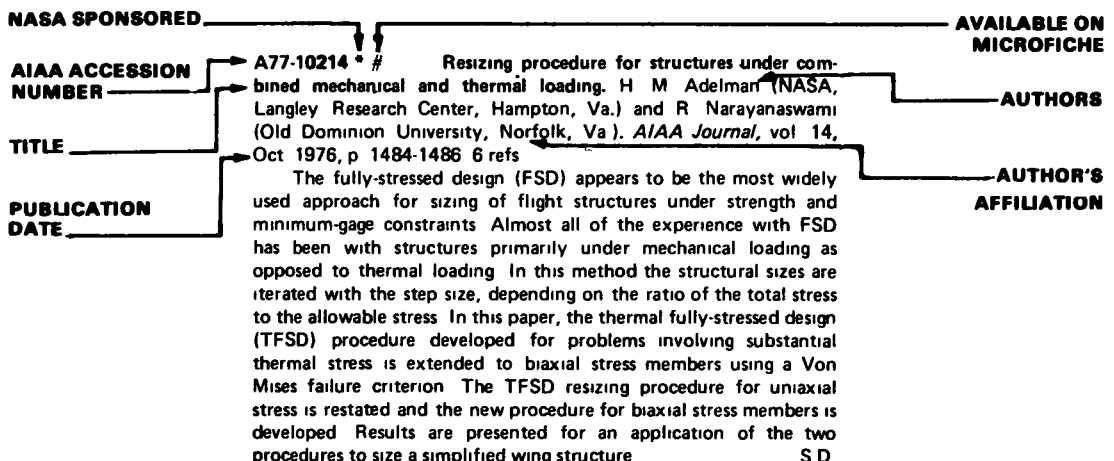
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AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 80)

FEBRUARY 1977

IAA ENTRIES

A77-10026 Centrifugal compressor and pump stability, stall and surge, Proceedings of the Conference, New Orleans, La., March 22-25, 1976. Conference sponsored by the American Society of Mechanical Engineers. Edited by P. C. Tramm (General Motors Corp., Indianapolis, Ind.) and R. C. Dean, Jr. (Creare, Inc., Hanover, N.H.). New York, American Society of Mechanical Engineers, 1976. 211 p. \$20.

Papers are presented on the control of surge in dynamic centrifugal compressors using close coupled resistances, controls for high energy centrifugal pumps to prevent pulsation and cavitation erosion, the time domain of centrifugal compressor and pump stability and surge, and the effect of rotor blade wakes on centrifugal compressor diffuser performance. Also considered are asymmetric flow in vaneless diffusers of centrifugal blowers, the effect of inlet flow conditions and geometries of centrifugal vaneless diffusers on critical flow angle for reverse flow, and a cascade analogy of vane diffuser influence on centrifugal compressor stability.

Individual items are announced in this issue

B J

A77-10032 The effect of rotor blade wakes on centrifugal compressor diffuser performance - A comparative experiment. S. Baghdadi (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.). In Centrifugal compressor and pump stability, stall and surge, Proceedings of the Conference, New Orleans, La., March 22-25, 1976. New York, American Society of Mechanical Engineers, 1976, p. 121-138. 5 refs.

A vortex nozzle facility for testing radial vane diffusers independently of any rotor has been developed (Baghdadi and McDonald, 1975 and Baghdadi, 1973). This paper describes a comparative experiment designed to evaluate the applicability of results obtained on this facility to actual rotating compressors. Geometrically scaled diffusers were tested in the vortex nozzle facility and in an actual rotating compressor rig, and the results are compared and shown to be very similar in terms of both performance and stability limits. The implications of these results are that rotor blade wake mixing and unsteadiness do not significantly affect diffuser performance. (Author)

A77-10036 Experimental investigation of the near-surge flow in a high performance centrifugal compressor. R. Sovrano and P. Avram (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In Centrifugal compressor and pump stability, stall and surge, Proceedings of the Conference, New Orleans, La., March 22-25, 1976. New York, American Society of Mechanical Engineers, 1976, p. 179-202. 16 refs.

By using several measuring means (Schlieren visualization technique, fluctuating pressure transducers and wall pressure taps), the experimental study of near surge flow in a high pressure ratio centrifugal compressor is conducted in order to emphasize the

fundamental influence of the diffuser on this phenomenon. The diffuser being choked, the shock wave system in the throat region seems mainly responsible for the surge onset, while in the opposite case (diffuser unchoked) the inlet flow incidence effect determines critically the compressor surge. For studying this very important parameter two rotation speeds were used (8,000 and 9,500 rpm in a freon set-up), corresponding to inlet relative Mach numbers at the inducer tip equal to 1.08 and 1.27 respectively. (Author)

A77-10197 The influence of vortex shedding on the generation of sound by convected turbulence. M. S. Howe (Cambridge University, Cambridge, England). *Journal of Fluid Mechanics*, vol. 76, Aug. 25, 1976, p. 711-740. 44 refs. Research supported by Rolls-Royce (1971), Ltd.

This paper discusses the theory of the generation of sound which occurs when a frozen turbulent eddy is convected in a mean flow past an airfoil or a semiinfinite plate, with and without the application of a Kutta condition and with and without the presence of a mean vortex sheet in the wake. A sequence of two-dimensional mathematical problems involving a prototype eddy in the form of a line vortex is examined. To the order of approximation to which the sound from convected turbulence near a scattering body is usually estimated, the imposition of a Kutta condition at the trailing edge leads to a complete cancellation of the sound generated when frozen turbulence convects past a semiinfinite plate, and to the cancellation of the diffraction field produced by the trailing edge in the case of an airfoil of compact chord. (Author)

A77-10200 # Concorde navigation. B. J. Calvert and T. C. R. Guest (International Association of Institutes of Navigation, International Congress, Boston, Mass., Aug. 2-6, 1976). *Journal of Navigation*, vol. 29, Oct. 1976, p. 358-363.

Problems peculiar to Concorde navigation practice are emphasized. These include special constraints dictated by considerations of fuel conservation and optimum fuel utilization (and shifting of center of gravity fore and aft by fuel transfer in flight), avoiding overflight of highly populated areas and particularly focusing of supersonic booms near such areas, and penalties in range and payload. Exact definition of waypoints selected for acceleration and deceleration, automated navigation functions required to alleviate the crew workload for concentration on other tasks, in-flight systems updating, and great-circle calculations at supersonic cruise altitudes are also mentioned. R. D. V.

A77-10207 # Application of optimality criteria to automated structural design. M. W. Dobbs and R. B. Nelson (California, University, Los Angeles, Calif.). *AIAA Journal*, vol. 14, Oct. 1976, p. 1436-1443. 15 refs. Grant No. AF AFOSR-74-2460A.

This paper presents a recursive design method for the minimum weight design of linear elastic redundant structures subject to

multiple independent static loading conditions and with behavioral constraints on allowable element stresses and nodal displacements and constraints on design variables. This recursive method is based on the Kuhn-Tucker necessary conditions for a local optimum and gives, upon completion, a local optimum design. An iterative procedure is used to resize the structure until a design satisfying the Kuhn-Tucker necessary conditions is obtained. For resizing, it is necessary to identify the current near-active (critical) constraints and to use this data to construct the Kuhn-Tucker test. If the current design is not converged, then the information from the test is used to resize the design variables and improve the design. Each iteration or redesign requires only the solution of a set of linear algebraic equations equal in number to the number of currently active constraints. The method is used to design several well known truss-type structures, and the results are shown to compare favorably with previous results obtained using mathematical programming algorithms and other optimality criteria methods. (Author)

A77-10208 # Experimental investigation of the boundary layer on a rotating cylinder J B Morton, I D Jacobson, and S Saunders (Virginia, University, Charlottesville, Va.) *AIAA Journal*, vol 14, Oct 1976, p 1458-1463 10 refs Grant No DAAD05-72-C-0131

This paper documents the experimental analyses done in determining the stability, transition, and growth of boundary layers on a spinning cylinder at angle of attack. It has been shown that spin alters the boundary-layer growth as well as skewing and moving forward the transition line. These effects can have a significant influence on the thickness distribution of the boundary layer. (Author)

A77-10214 * # Resizing procedure for structures under combined mechanical and thermal loading H M Adelman (NASA, Langley Research Center, Hampton, Va.) and R Narayanaswami (Old Dominion University, Norfolk, Va.) *AIAA Journal*, vol 14, Oct 1976, p 1484-1486 6 refs

The fully-stressed design (FSD) appears to be the most widely used approach for sizing of flight structures under strength and minimum-gage constraints. Almost all of the experience with FSD has been with structures primarily under mechanical loading as opposed to thermal loading. In this method the structural sizes are iterated with the step size, depending on the ratio of the total stress to the allowable stress. In this paper, the thermal fully-stressed design (TFSD) procedure developed for problems involving substantial thermal stress is extended to biaxial stress members using a Von Mises failure criterion. The TFSD resizing procedure for uniaxial stress is restated and the new procedure for biaxial stress members is developed. Results are presented for an application of the two procedures to size a simplified wing structure. S D

A77-10218 # Anisotropic radiatively coupled wedge flow J B Elgin and J R Baron (MIT, Cambridge, Mass.) *AIAA Journal*, vol 14, Oct 1976, p 1492-1494 7 refs Contract No F44620-75-C-0040

Geometrically thin shock layers are advantageous in reducing the radiation heat transfer to a high-speed body. Since elongated shock layers imply anisotropic radiation fields, the differential Milne-Eddington approximation used by Gibelet and Baron (1973) for minimum radiative transfer geometries is somewhat questionable for anisotropic shock layers. The utility of ellipsoidal modeling for both anisotropic and coupled fields is assessed. Attention is focused on an application of the concept to a radiatively coupled wedge flow. A realistic basis is provided for examining the adequacy of the differential approximation for shock layers. It is shown that even in instances of overall insignificant reabsorption, ellipsoidal modeling is of some importance to the distributed absorption influence. S D

A77-10251 Approximate transonic profile flow with shock R Mitra (Lady Brabourne College, Calcutta, India) *Acta Mechanica*, vol 25, no 1-2, 1976, p 1-12 13 refs

The present work gives a procedure for computing approximately steady inviscid transonic profile flow with shock. Using an analysis similar to that adopted by Hosokawa (1960), it extends the shock-free transonic solution of Niyogi and Mitra (1973) to the case of flow with shock. Supercritical flow past parabolic arc profiles and a NACA profile are computed and compared with theoretical results of Oswatitsch and Zierep and finite difference solution of Murman and Cole (1971) and with experimental results. The agreements are satisfactory. (Author)

A77-10336 * Optimal ride control for the Twin Otter, STOL aircraft W E Holley (Oregon State University, Corvallis, Ore.) In Annual Asilomar Conference on Circuits, Systems, and Computers, 9th, Pacific Grove, Calif., November 3-5, 1975, Conference Record North Hollywood, Calif., Western Periodicals Co., 1976, p 585-590 5 refs Research supported by the Oregon State University, Grant No. NCA-OY586 501

An aircraft with low wing loading, such as the deHavilland, Twin Otter, exhibits a relatively large acceleration sensitivity to wind gusts. These undesirable aircraft motions can be reduced using an automatic ride control system. In this paper, the techniques of quadratic optimal control theory are utilized to investigate the capabilities of such a ride control system. The effects of the wind gusts on the aircraft can be modeled by a vector stochastic process containing seven states. The impact of this disturbance model on the optimal control system structure is assessed and comparison is made to a system without gust feedback. (Author)

A77-10338 Eigenvalue/eigenvector control via spectral characterization - An application to helicopter hover dynamics S Srinathkumar and R P Rhoten (Oklahoma State University, Stillwater, Okla.) In Annual Asilomar Conference on Circuits, Systems, and Computers, 9th, Pacific Grove, Calif., November 3-5, 1975, Conference Record North Hollywood, Calif., Western Periodicals Co., 1976, p 605-609

A linear state feedback gain selection procedure which allows arbitrary choice of eigenvalues and certain eigenvector entries and thus provides direct control of closed loop responses is described. The technique is illustrated by synthesizing a hover controller for a ninth order model of the SH-3D helicopter, with emphasis on stabilization and mode decoupling. B J

A77-10347 A note on the acoustic effect of non-uniformly distributed stator rows P E Duncan (Central London, Polytechnic, London, England) *Journal of Sound and Vibration*, vol 48, Oct 8, 1976, p 441-444 Science Research Council Grant No B/RG/85125

A technique for reducing tonal radiation from axial flow fans is described which treats the complete downstream stator row as three vane sets (each evenly distributed) and then arranges the circumferential and axial positions of the sets relative to each other so as to achieve self-cancellation of the principal interaction pattern. Computed results are presented for a hypothetical fan with a blade tip Mach number of 0.58 and a hub-tip ratio of 0.83. Results show that the overall noise reduction of 6-9 dB originally anticipated is not approached and that the technique is of little value for faster fans (for effective Mach numbers not less than 0.4 and not greater than 0.6). B J

A77-10349 # Program system for computer calculations of jet engine characteristics (Sistema programm dlia rascheta kharak-

teristik VRD na ETsVM) V I Iankin Moscow, Izdatel'stvo Mashinostroenie, 1976 168 p 13 refs In Russian

The book describes a specialized system of procedures for calculations of gasdynamic processes and high velocity and throttle characteristics of jet engines, with special attention given to methods which are common to all types of jet engines. These procedures are then codified in ALGOL-60, forming a program system. The system is drawn up in two variants, one for computers with small operational memory and compilers with limited number of formal procedural parameters, and one for computers with large memory and many formal parameters P T H

A77-10383 Strength of compressor wheels of low-ductility alloys I A Kozlov, L R Shlik, V N Gorodetskii, L I Nemchenko, and V L Akhremenko (Akademia Nauk Ukrainsoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) (*Problemy Prochnosti*, Jan 1976, p 92-97) *Strength of Materials*, vol 8, no 1, Oct 1976, p 91-95 Translation

A77-10416 Flow of a radiating gas over a blunt body with intense vaporization V P Stulov and V N Mirskii (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) (*Teplofizika Vysokikh Temperatur*, vol 14, Jan-Feb 1976, p 112-119) *High Temperature*, vol 14, no 1, July 1976, p 98-104 15 refs Translation

A77-10438 A systems approach to all weather landings L S Gephart, W P Fuchs (Dayton, University, Dayton, Ohio), G L Fileccia, T Johani (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), and H G Tinsley (FAA, Terminal Navigation Branch, Washington, D C) In Annual Reliability and Maintainability Symposium, Las Vegas, Nev., January 20-22, 1976, Proceedings New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p 25-30

This paper describes the modeling techniques adopted for a reliability/safety analysis of a unique FAA-AFFDL flight test program. The program utilizes a large turbojet aircraft to gain approach and landing experience in Category III weather. The total system includes the ground transmitting system with monitoring, the airborne flight control system (modified and augmented) as used in the automatic landing model with safety pilot and crew 'in the loop', and procedures, both standard and special. The modeling techniques partition the vertical and lateral axes/functions and sub-divide the longitudinal or time axis into contiguous non-overlapping sub-intervals. Analysis techniques, progress and present status are discussed (Author)

A77-10442 Reliability of automated flight service stations N B Fuqua (IIT Research Institute, Griffiss AFB, N Y) In Annual Reliability and Maintainability Symposium, Las Vegas, Nev., January 20-22, 1976, Proceedings New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p 113-119 10 refs Contract No F30602-73-C-0065

The flight service station (FSS) is an FAA air traffic control operational facility which provides services to pilots operating general aviation, civil air carrier, and military aircraft. There are currently more than 300 Flight Service Stations within the contiguous U.S. The upgrading and automatization of the FSS system is considered. An investigation is conducted to compare the reliability, maintainability, and availability (RMA) impact of three possible system configurations under study. The study demonstrates the effectiveness of the 'Single-Thread Functional Availability Modeling'

techniques as a tool in examining and defining the RMA characteristics of a complex automated system which is required to randomly perform a number of unique functions G R

A77-10483 Interface between maintainability and commercial aircraft spares support. J E Losee (Douglas Aircraft Co., Long Beach, Calif) In Annual Reliability and Maintainability Symposium, Las Vegas, Nev., January 20-22, 1976, Proceedings New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p 500-503

A review of all aspects of the DC-10 program revealed that a new approach to spares support is imperative if an aircraft and a support system that would be financially attractive in the market place were to be produced. The general methodology currently used by Douglas Aircraft to develop the spare support program for the D-10 is described V P

A77-10500 Investigation and analysis of the human factors in aircraft accidents (Investigación y análisis de factores humanos en los accidentes de aviación) A Perez Griffo (Centro de Investigación de Medicina Aeronáutica, Spain) *Revista de Aeronáutica y Astronáutica*, vol 36, Sept 1976, p 711-720 16 refs In Spanish

Aerospace medicine is concerned with the study of the physiopathological conditions existing during the flight and the determination of the psychophysical conditions which are desired for the members of the flight crew. Attention must be given to human reactions in response to extraordinary situations which can occur. It has been found that the reaction of the pilot is an important contributing factor in many aircraft accidents. A description is given of the various aspects which have to be investigated in the study of the human factors. The approaches which have to be employed in the investigation of aircraft accidents are discussed, taking into account studies at the location of the accident, laboratory studies, and organizational aspects G R

A77-10524 Israel's pride of Lions *Air International*, vol 11, Nov 1976, p 220-225, 248, 249

The delivery embargo imposed by the French government in 1967 on 50 Mirage 5J fighter-bombers for the Israel Defense Force together with a subsequent extension of the embargo led to the decision to manufacture the Mirage in Israel. A licence was acquired for the General Electric J79-GE-17 engine and the basic Mirage 5J airframe was redesigned around this power plant. Attention is given to the properties of the aircraft as a dogfighter, details of aircraft design, aspects of aircraft production, and plans for export sales G R

A77-10525 YC-14 - All blow and no puff *Air International*, vol 11, Nov 1976, p 227-232

The AMST program, which grew out of a Tactical Air Command requirement drawn up in 1970, is to provide a successor for the C-130 Hercules. In connection with the introduction of new army weapons and equipment of greater size and weight, the Hercules can today carry only 55% of all combat brigade vehicles whereas the AMST is dimensioned to carry 90%. The AMST can operate into and out of many airfields that would be unacceptable for the C-130. The YC-14 design for the AMST is discussed, taking into account details of aircraft structure, the power plant, aircraft performance, and the ability of the aircraft to meet mission requirements G R

A77-10648 Simulating the last 100 ft J Belson *Flight International*, vol 110, Oct 23, 1976, p 1264-1266

Compu-Scene, a computer-generated-image visual display system fitted to the flight simulators of an American aerospace company,

has been awarded Federal Aviation Administration approval for training purposes. The optics of the system provide an infinity view through the windscreens and side windows on the flight deck. Each unit is supplied with a full-color video signal representing an accurate perspective view of the outside world as it would appear from the flight deck for any position and attitude of the aircraft. CompuScene offers a full daylight scene suitable for touch-down training.

G R

A77-10664 Pressure distributions over frontal /nose/ surfaces of bodies of revolution in transonic flow at angles of attack of 0 to 10 deg. P. G. Leutin (*TsAGI, Uchenye Zapiski*, vol 5, no 2, 1974, p 130-135) *Fluid Mechanics - Soviet Research*, vol 4, Nov-Dec 1975, p 18-24. 5 refs. Translation.

A77-10665 The hyperbolicity of integral equations of momentum in a three-dimensional incompressible laminar boundary layer. V. A. Barinov (*TsAGI, Uchenye Zapiski*, vol 5, no 2, 1974, p 55-60) *Fluid Mechanics - Soviet Research*, vol 4, Nov-Dec 1975, p 25-31. 14 refs. Translation.

A77-10697 Bird hazards to aircraft. Problems and prevention of bird/aircraft collisions. H. Blokpoel (Environment Canada, Canadian Wildlife Service, Ottawa, Canada). Research sponsored by the National Research Council of Canada, Ministry of Transport and Department of National Defence. Toronto, Clarke, Irwin and Co., Ltd., 1976. 250 p. 445 refs. \$9.50.

Information on birds and on bird migration is presented and data of bird strike statistics are examined, taking into account aspects of bird classification and identification, bird numbers, bird sizes and weights, the annual cycle of bird migration, methods of studying migration, heights of migration, the behavior of birds with respect to approaching aircraft, and the types of damage resulting from bird strikes. Work related to the bird-proofing of aircraft and engines is considered and a description is given of a search for on-board equipment to disperse birds. Approaches for the prevention of bird strikes are discussed, giving attention to bird observation methods, bird dispersal methods, habitat manipulation, and procedures to minimize strike risks during periods of high bird densities.

G R

A77-10771 # Unsteady pressure distributions on oscillating airfoils in a supersonic cascade. M. Kurosaka (GE Research and Development Center, Schenectady, NY) *ASME, Transactions, Series A - Journal of Engineering for Power*, vol 98, Oct 1976, p 553, 554.

In Kurosaka's exact first-order theory for the unsteady supersonic cascade with a subsonic leading edge, the expression for the pressure distribution - written in general form and applicable to any cascade geometry - is disturbingly lengthy in appearance. In the present note, it is shown that for cascade geometries of practical interest, the expression for the unsteady pressure distribution can be reduced to a much simpler form.

V P

A77-10772 # Pressure loss coefficient of impingement cooled leading edge system of a turbine blade. D. K. Mukherjee (Brown, Boveri et Cie AG, Baden, Switzerland) *ASME, Transactions, Series A - Journal of Engineering for Power*, vol 98, Oct 1976, p 554-556. 18 refs.

The pressure loss coefficient of an impingement cooled system

similar to that often used to cool the leading edge of a turbine blade has been determined from model test. The influence of Reynolds number in the range tested is negligible. However, the influence of relative distance of the jet holes from the surface to be cooled is very significant.

(Author)

A77-10773 # Film cooling with injection through slots. D. K. Mukherjee (Brown, Boveri et Cie AG, Baden, Switzerland) *ASME, Transactions, Series A - Journal of Engineering for Power*, vol 98, Oct 1976, p 556-559. 23 refs.

This work deals with film cooling of a surface with injection through slots. From the vast number of literatures surveyed, the cooling effectiveness for an ideal geometry - a flat plate with no pressure gradient having tangential blowing from a slot with no lip thickness - could be found by using a suitable blowing parameter for three different regions. The influence of blowing angle and lip geometry has been investigated and defined, each separately.

(Author)

A77-10854 # Forces on unstaggered airfoil cascades in unsteady in-phase motion. N. H. Kemp (Avco Everett Research Laboratory, Inc., Everett, Mass.) and H. Ohashi (Tokyo, University, Tokyo, Japan) (*American Society of Mechanical Engineers, Paper 76-FE-S*, 1976) *ASME, Transactions, Series I - Journal of Fluids Engineering*, vol 98, Sept 1976, p 521-530. 18 refs.

Incompressible flow through an unstaggered cascade in general, unsteady, in-phase motion is considered. By methods of thin airfoil theory, using the assumptions of wakes trailing back at the through-flow velocity, and the Kutta condition, exact analytical expressions are derived for loading, lift and moment. As application,

A77-10855 # Flow interaction near the tail of a body of revolution. I - Flow exterior to boundary layer and wake. A. Nakayama, V. C. Patel, and L. Landweber (Iowa, University, Iowa City, Iowa) (*American Society of Mechanical Engineers, Paper 76-FE-M*, 1976) *ASME, Transactions, Series I - Journal of Fluids Engineering*, vol 98, Sept 1976, p 531-537. 18 refs. Research supported by the University of Iowa, Contract No. N00014-68-A-0196-0002.

An iterative procedure for the calculation of the thick attached turbulent boundary layer near the tail of a body of revolution is presented. The procedure consists of the potential-flow calculation by a method of integral equation of the first kind and the calculation of the development of the boundary layer and the wake using an integral method with the condition that the velocity remains continuous across the edge of the boundary layer and the wake. The additional terms that appear in the momentum integral equation for the thick boundary layer and the near wake are taken into account and the pressure difference between the body surface and the edge of the boundary layer and the wake can be determined. The results obtained by the present method are in good agreement with the experimental data.

(Author)

A77-10856 # Flow interaction near the tail of a body of revolution. II - Iterative solution for flow within and exterior to boundary layer and wake. A. Nakayama, V. C. Patel, and L. Landweber (Iowa, University, Iowa City, Iowa) (*American Society of Mechanical Engineers, Paper 76-FE-N*, 1976) *ASME, Transactions, Series I - Journal of Fluids Engineering*, vol 98, Sept 1976, p 538-546, Discussion, p 546-548, Author's Closure, p 548, 549. 33 refs. Research supported by the University of Iowa, Contract No. N00014-68-A-0196-0002.

This part deals with the calculation of the flow within the

attached boundary layer and the wake of a body of revolution and its interaction with the external potential flow which was treated in Part 1. The iterative technique described in Part 1 is used to obtain a complete solution to the flow in the neighborhood of the tail of the body. The results of the calculations are compared with two sets of experimental data and reasonable agreement is demonstrated.

(Author)

A77-10882 # **Dual-spin spacecraft dynamics under conditions of a rotating unbalanced platform and rotor asymmetry** G J Adams (Hughes Aircraft Co., Space and Communications Group, Los Angeles, Calif.) *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-019* 9 p 14 refs

Design of the attitude stabilization system of a dual-spin spacecraft is based primarily on proper management of internal energy dissipation with the platform despin. If the platform is rotating, however, the dynamic response is determined by platform dynamic imbalance and rotor transverse inertia symmetry in addition to energy dissipation effects. The rotating platform case is important as a temporary condition from which it is desired to recover. The paper gives a heuristic description of the vehicle dynamics for roll/pitch ratios above and below unity, a summary of in-orbit experience with the TACSAT and DSCS-2 satellites, and a description of some of the design features and operational procedures utilized on current dual-spin spacecraft to ensure recovery from various failure mode conditions.

(Author)

A77-10911 # **The fuel approach to control emissions from aircraft** R W Hurn (ERDA Bartlesville Energy Research Center, Bartlesville, Okla.) *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-111* 7 p

Control of fuel composition may provide a means to control or affect the emission of metals, sulfur, smoke, and nitrogen oxides. Metals emissions can be related to the occurrence of metals as trace elements in crude oils and to an erosion of metal engine parts. Sulfur in fuel constitutes the only significant source of that element or its derivatives in turbine exhausts. Suitable approaches for reducing the amount of sulfur and sulfur oxide emissions are considered.

G R

A77-10912 * # **Effects of atmospheric conditions on the operating characteristics of supersonic cruise aircraft** W G Schweikhard, G B Gilyard (NASA, Flight Research Center, Edwards, Calif.), J E Talbot, and T W Brown (British Aircraft Co., Bristol, England) *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-112* 21 p 20 refs

Since for maximum range a supersonic transport must cruise near its maximum Mach number, accurate flight control is needed, especially when severe atmospheric transients are encountered. This paper describes atmospheric transients that have been encountered by the XB-70, YF-12, and Concorde aircraft during supersonic flights and the ensuing responses of the aircraft propulsion and flight control systems. It was found that atmospheric conditions affected these supersonic cruise vehicles in much the same way, with minor differences according to the type of propulsion and flight control system. Onboard sensors are sufficiently accurate to provide data on the atmosphere, including turbulence over the route, that are accurate enough for entry in the climatic record and for use as inputs to the control systems. Nominal atmospheric transients can be satisfactorily controlled, but some problems remain for extreme cases.

(Author)

A77-10939 # **Strength of glass-fibre-reinforced plastics at one-sided heating** G S Pisarenko and G N Tret'yachenko (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper 76-200* 8 p 11 refs

The surfaces of modern high-speed aircraft are protected from aerodynamic heating by coatings prepared of ablating materials, such as fiberglass laminates, asbestos textolites, carbon-base materials, and composites, each of whose elements serves a specific (load-carrying, insulating, etc.) purpose. The facilities described in the present paper are designed for testing such protective coatings in bending, tension, or compression under unilateral heating. Some techniques used to simulate the actual heating conditions are discussed.

V P

A77-10972 # **Beyond supersonic transport** S B Rosenfield (New England School of Law, Boston, Mass.) *International Astronautical Federation, International Astronautical Congress, 27th, Anaheim, Calif., Oct. 10-16, 1976, Paper ISL-76-66* 14 p 7 refs

The legal aspects of a future civil transport system consisting of travel both in the atmosphere and in outer space - the civil air-space transport system - are considered. The discussion is based on the separate examination of space law and air law.

B J

A77-11195 * **Development of aircraft brake materials** T-L Ho and M B Peterson (Rensselaer Polytechnic Institute, Troy, NY) *American Society of Lubrication Engineers and American Society of Mechanical Engineers, Lubrication Conference, Boston, Mass., Oct. 5-7, 1976, ASLE Preprint 76-LC-1B-3* 6 p 5 refs. Grant No. NGR-33-018-152

A program has been carried out to study and develop high temperature aircraft brake materials. A survey of the requirements of brake materials was made to select materials to meet these requirements. Based upon their physical and thermal properties, a number of materials were selected and evaluated in sliding tests which simulated aircraft braking. The mating material is 17-22 AS steel. Additives were incorporated into these materials to optimize their wear or strength behavior with particular emphasis on nickel and molybdenum base materials. Optimum materials were developed which had improved wear behavior over conventional brake materials in the simulated test. The best materials were a nickel, aluminum oxide, lead tungstate composition containing graphite and a molybdenum base material containing LPA 100 (an intermetallic compound of cobalt, molybdenum and silicon).

(Author)

A77-11261 **Competition for airspace - Bird strikes and aircraft operations** R W Doughty (Texas, University, Austin, Tex.) *Traffic Quarterly*, vol 30, July 1976, p 449-467 16 refs. Research supported by the University of Texas.

The hazards of bird collisions with aircraft are examined and the growing encroachments of airports on wildlife habitats, particularly for certain species of birds, are noted. Tables are presented containing information on significant bird-aircraft strikes from 1960 to 1974 and annual variations in damaging bird strikes, US Air Force 1956-1972. The relation of inflight collision risks and bird migration is investigated as are bird hazards on airport environments. Methods for reducing bird hazards including distress calls, noise makers, chemical repellents, pyrotechnics and falconry are discussed.

B J

A77-11276 **European Rotorcraft and Powered Lift Aircraft Forum, 1st, University of Southampton, Southampton, England, September 22-24, 1975, Proceedings** *Vertica*, vol 1, no 1, 1976. 93 p

The first issue of a new periodical devoted to rotorcraft and powered lift aircraft covers numerous topics in rotorcraft engineering and applications. Topics represented include circulation control rotors and stowed rotors, winged rotorcraft, rotor and flap control systems, vibration analysis and control, hingeless rotors, comparative studies of passenger-service VTOL, STOL, and CTOL capabilities and shortcomings, and rotor-emitted noise analysis and abatement.

Individual items are announced in this issue

R D V

A77-11277 **Application of circulation control rotor technology to a stopped rotor aircraft design** R M Williams (U S Naval Material Command, Ship Research and Development Center, Bethesda, Md) (*European Rotorcraft and Powered Lift Aircraft Forum, 1st, Southampton, England, Sept 22-24, 1975*) *Vertica*, vol 1, no 1, 1976, p 3-15 6 refs

Design and performance of a hybrid X-wing stopped-rotor V/STOL aircraft optionally powered by outboard fan engines and top-mounted slot-blowable rotary wing lift are described. Application of circulation control rotor (CCR) technology to the concept is discussed. Handling of transition lift by blowing out of rotor slots separately or in unison and resulting advantages are dealt with. Rotor design, blade and disk loading, and blade weight analysis are covered in addition to fixed-wing and rotary-wing performance modes (including stopped-wing mode, stowed-wing mode, and blown fixed-wing mode). Aeroelastic bending divergence in the stopped-wing mode, resonant amplification of blade vibratory bending stresses during rotor slowing and stopping, and potential high-frequency coupled instabilities of isolated blades, multi-blades, and rotor/body combination are critical.

R D V

A77-11278 **Advanced control systems for helicopters** I A Simons (Westland Helicopters, Ltd, Yeovil, Somerset, England) (*European Rotorcraft and Powered Lift Aircraft Forum, 1st, Southampton, England, Sept 22-24, 1975*) *Vertica*, vol 1, no 1, 1976, p 17-29

Some of the basic control and stability problems that are typical of the present day helicopter are discussed and their part in defining rotor characteristics is indicated. The idea of demand types of control systems is introduced as a possible solution to these problems and as a means to releasing some of the present rotor design constraints - particularly in rotor stiffness. In order to illustrate the potential freedom in helicopter design resulting from the adoption of very stiff rotors, their use in a coaxial system is briefly discussed.

(Author)

A77-11279 **Reducing vibration by structural modification** G T S Done and A D Hughes (Edinburgh, University, Edinburgh, Scotland) (*European Rotorcraft and Powered Lift Aircraft Forum, 1st, Southampton, England, Sept 22-24, 1975*) *Vertica*, vol 1, no 1, 1976, p 31-38

Selection of criteria for singling out those elements of a helicopter fuselage structure to be treated as variables in a model designed to aid minimization of vibration response by modifying the fuselage structural design are discussed. Pinpointing sensitive and crucial structural elements or parts with respect to vibration performance of a newly assembled helicopter to minimize vibration response in the passenger and crew area is also dealt with. Structural response theory, relevant analysis and mathematical properties, sensitivity criteria, and application to a simplified 60 DOF helicopter fuselage structure are discussed. The gearbox and tail cone substructures are found crucial areas for fuselage modification to achieve vibration abatement in the passenger and crew area.

R D V

A77-11280 **Hingeless rotor dynamics in high speed flight.** H Huber and H Strehlow (Messerschmitt Bolkow-Blohm GmbH, Ottobrunn, West Germany) (*European Rotorcraft and Powered Lift Aircraft Forum, 1st, Southampton, England, Sept 22-24, 1975*) *Vertica*, vol 1, no 1, 1976, p 39-53 11 refs

A high speed flight research program has been carried out on MBB BO 105 Hingeless Rotor behavior within an expanded flight envelope. True airspeeds of 200 kt (pure helicopter version) and of 218 kt (winged helicopter version) were achieved in dive conditions, corresponding to advance ratios up to 0.53 and advancing blade tip Mach numbers up to 0.97. Rotor blade versions with constant thickness airfoil, and with thin tip modifications were evaluated. Essential test results are compared to theoretical investigations. Main emphasis is placed upon rotor structural loads, control and stability behavior, and aeroelastic stability characteristics. A continuous picture of hingeless rotor characteristics over a wide speed and maneuver range is presented.

(Author)

A77-11281 **Rotor impedance measurements at model scale** D R Gaukroger and R Cansdale (Royal Aircraft Establishment, Structures Dept, Farnborough, Hants, England) (*European Rotorcraft and Powered Lift Aircraft Forum, 1st, Southampton, England, Sept 22-24, 1975*) *Vertica*, vol 1, no 1, 1976, p 55-66

A test rig has been built at the Royal Aircraft Establishment to measure the shaft impedances of model rotors in hover conditions. Model rotors up to about 3 m in diameter can be tested - that is to say, 1/5 or 1/4 scale models of an 'average' rotor. The method of test is to oscillate the rotor shaft in a particular direction over a range of frequencies and to measure the force or moment required to produce the oscillation, and the forces and moments required to prevent oscillation in any other direction. Provision is made for shaft motion either in a pitching direction about a rotor diameter or in a translatory direction in the rotor plane. An automatic excitation and on-line analysis system enables all the forces and moments per unit motion (rotor impedances) to be calculated and displayed. Complete matrices of rotor shaft impedances can be used either to check theory or to assess the stability of the rotor when it is joined to a fuselage. In the latter case, the impedance matrix of the fuselage must also be determined.

(Author)

A77-11282 **A wing on the SA 341 Gazelle helicopter and its effects** M Torres (Société Nationale Industrielle Aérospatiale, Division Hélicoptères, Marignane, Bouches-du-Rhône, France) (*European Rotorcraft and Powered Lift Aircraft Forum, 1st, Southampton, England, Sept 22-24, 1975*) *Vertica*, vol 1, no 1, 1976, p 67-73

Control surfaces, handling, flight testing, and adjustments of the SA 349 or SA 341 helicopters are discussed. A low-mounted wing (area 54 sq ft), wing-mounted airbrakes functioning as lift spoilers, and an in-flight trimmable stabilizer and their effects were tested on a flying prototype. Results of wind-tunnel tests, simulator tests, reference flight tests, and basic flight tests are stated. Airbrakes were fitted onto upper and lower wing surfaces as the wing adversely affects autorotation, producing high wing lift, unloading the rotor, and decreasing rotor rpm. Interactions between wing and stabilizer, adjustments of wing area, dihedral and incidence angles, use of removable wing tips and adjustable struts, and stabilizer settings are described, along with quick-stop maneuvers using airbrakes, wing stall, and behavior in dive, banking, and hover.

R D V

A77-11283 **Intercity VTOL aircraft - A Hawker Siddeley review** M J Brennan (Hawker Siddeley Aviation, Ltd, Kingston-on-Thames, Surrey, England) (*European Rotorcraft and Powered Lift Aircraft Forum, 1st, Southampton, England, Sept 22-24, 1975*) *Vertica*, vol 1, no 1, 1976, p 75-88 11 refs

Comparisons between CTOL, STOL, and VTOL flight in passenger service are made for a wide range of criteria. Comparative data are tabulated and diagrammed for passenger seat-km and loads, take-off and landing regimes, approach speed and angle, runway length, required airport area, noise footprints, airport costs, air traffic segregation, first costs and operating costs, total journey costs and total journey time, fuel consumption and flight time, time response to weather data, and instrumentation demands. Service to low-density communities, intercity shuttle traffic, and detrimental social and political aspects of CTOL service are stressed. STOL disadvantages in terminal-phase gust conditions are cited. Time required to develop a V/STOL transport system from scratch is considered. R D V

A77-11284 Rotational noise measurement in a wind tunnel by total sampling synchronization. C. Armand (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) (*European Rotorcraft and Powered Lift Aircraft Forum, 1st, Southampton, England, Sept 22-24, 1975*). *Vertica*, vol 1, no 1, 1976, p 89-92.

A new method, total sampling synchronization (TSS), for extracting the rotational noise of an advancing rotor blade from wind tunnel noise is described. The TSS method provides the best adaptation of numerical Fourier analysis to rotational noise or other periodic phenomena. Rotorcraft rotational noise is singled out as the most troublesome and discomforting noise contribution emitted in flight, but deficiencies of in-flight measurements (relative positions of microphones and rotorcraft, limitation of speeds of existing rotorcraft and rotors, and poor representation from onboard microphone signals) dictate the use of high-speed wind tunnels for noise testing. Noise spectral analysis with correlations, with partial synchronization of sampling, with total sampling synchronization, and uncorrelated, is examined and compared. R D V

A77-11311 Co-operation in the European aircraft manufacturing industry and among the scheduled airlines. /Brancker Memorial Lecture/ K. Hægrop (Scandinavian Airlines System, Bromma, Sweden, International Chamber of Commerce, Paris, France) (*Chartered Institute of Transport Journal*, vol 37, May 1976, p 93-104).

Cooperation (rather than competition) as the aviation industry has achieved it in AECMA (European Association of Aerospace Manufacturers), in AEA (Association of European Airlines), in ECAC (European Civil Aviation Conference), in KSSU (KLM, SAS, SWR, UTA) and in ATLAS (Air France, Alitalia, Iberia, Lufthansa, Sabena) and other cooperating groups in Europe is discussed. Particular emphasis is on the EEC commission's proposal regarding extended cooperation and centralization of the aerospace manufacturers and airlines of the EEC. Modifications of the EEC commission's proposal are suggested. B J

A77-11312 Transport progress in practice. Air transport in Africa - East African Airways Corporation Experience. A. B. S. Kilewo (East African Airways Corp., Nairobi, Kenya) (*Chartered Institute of Transport, Congress, Nairobi, Kenya, May 1976*). *Chartered Institute of Transport Journal*, vol 37, July 1976, p 128-132.

Some major problems facing the development of air transport industry in Africa are outlined, and the part played by the air transport industry in the economic development of the East African countries is examined. The formation of an African multinational freight airline is proposed as a means of stimulating air cargo transportation among African countries. The formation of such an airline could start with regional integration and the formation of stronger airlines in the African subregions. The need for a coordinated transport policy and mutual assistance is emphasized. V P

A77-11325 High-nickel alloys for gas turbines. J. H. DeBord (Huntington Alloys, Inc.) (*Gas Turbine International*, vol 17, Sept-Oct 1976, p 28-30).

Mechanically alloyed and conventionally alloyed high-nickel refractory alloys for gas-turbine design applications are discussed along with their advantages and applications. The article deals with Inconel grades MA 754, MA 757E, 617, 625, 718, and 706, and with Incoloy grades MA 956E, 903, and MA 757E. Aerospace applications are given emphasis, including use of Incoloy alloy 903 in the Space Shuttle Main Engine. Use of Inconel 625 in aircraft ducting systems, engine exhaust systems, thrust reverse systems, honeycomb structures, heat exchanger tubing, Inconel 718 in compressor and turbine discs, blades, and shafts, Inconel 718 in rocket engines and in Space Shuttle, and Inconel MA 754 in vanes and shrouds are among the applications mentioned. R D V

A77-11477 Estimating fatigue-crack lives for aircraft - Techniques. J. P. Gallagher (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) (*Society for Experimental Stress Analysis, Spring Meeting, Chicago, Ill., May 11-16, 1975*). *Experimental Mechanics*, vol 16, Nov 1976, p 425-433. 24 refs.

Some complex aircraft stress histories, steady-state spectra, are noted to induce fatigue-crack growth-rate behavior similar to that observed under constant-amplitude loading. The paper identifies the behavior induced by steady-state spectra, and attributes the behavior to spectrum-stress-event periodicity. Spectrum periodicity is subsequently defined by isolating the group of statistically repetitive stress events. The noted crack-growth-rate behavior that exists for steady-state spectra provides the analyst with new techniques for estimating crack lives. Several crack-life estimating techniques are compared, for the two steady-state spectra considered herein, one technique called the simple-crack incrementation-miniblock approach provides life estimates with the same accuracy as that given by the cycle-by-cycle life-prediction method studied but does so five times more efficiently. The reasons for associated accuracy and efficiency are discussed. (Author)

A77-11594 Investigation into the optimum use of advanced displays in future transport aircraft. R. E. Hillman (British Aircraft Corp., Weybridge, Surrey, England) and J. W. Wilson (Hawker Siddeley Aviation, Ltd., Hatfield, Herts, England) (*Royal Aeronautical Society, Spring Convention on Seeds for Success in Civil Aircraft Design in the Next Two Decades, London, England, May 19, 20, 1976*). *Aeronautical Journal*, vol 80, Sept 1976, p 377-384.

New and future systems and formats for presentation of flight information to pilots are examined from the standpoint of pilot acceptance, pilot work load, and operating costs. Demonstration of positive engineering and pilot performance advantages is demanded, and weighed against potential improvements in the human-display system. Flight deck instrumentation is broadly divided into three categories with different characteristics dictated by safety, precision, cost, and work load needs: flight, engine, and system displays. A comparison is set up between a two-crew flight deck outfitted with 7 CRT displays and a contemporary 3-engine 3-crew wide-bodied aircraft. Development of flexible electronic attitude director indicators and horizontal situation indicators with all required navigation and flight information efficiently displayed, untimely and superfluous data suppressed, and relevant data integrated onto a smaller display area, is encouraged. R D V

A77-11595 Future trends in aero gas turbine design II - Unconventional engines. R. M. Denning, S. C. Miller, and G. H. Wright (Rolls Royce /1971/, Ltd., Aero Div., Bristol, England).

(Royal Aeronautical Society, Spring Convention on Seeds for Success in Civil Aircraft Design in the Next Two Decades, London, England, May 19, 20, 1976) *Aeronautical Journal*, vol 80, Sept 1976, p 385-393 9 refs

Unconventional types of aircraft gas turbine (GT) engines reviewed are so treated in the sense of unconventional uses (other than propulsion) for the GT engine, modification of the thermodynamic cycle under some flight conditions, or use of extremes of the constant-pressure GT cycle. Variant thermodynamic/aerodynamic cycles under consideration include a heat-exchanger engine, propulsion systems with ingestion or re-energizing of wake or boundary layer to reduce drag, and systems resorting to laminar flow control or boundary layer suction. Engines featuring in flight variation of the thermodynamic cycle include those using variable turbine stators, SST variable-cycle engines with compressor switching valve system, and variable-pitch fan engines. Engines developing vertical lift in addition to propulsive thrust include blow-fan engines, externally blown flap engines, and rotatable remote lift/propulsion fan engines. R D V

A77-11603 Signal-treatment methods during aircraft-engine inspection based on vibroacoustic noises V V Izokh and V I Mikulovich (Belorusskii Gosudarstvennyi Universitet, Minsk, Belorussian SSR) (*Defektoskopiia*, Jan-Feb 1976, p 39-47) *Soviet Journal of Nondestructive Testing*, vol 12, no 1, Nov 1976, p 29-34 15 refs Translation

Several methods of signal analysis for vibroacoustic flaw detection applied to the rotating parts of aircraft engines are described. The methods considered are spectral analysis and correlation analysis, and it is found that it is desirable to use synchronous detection and spectral analysis with high resolution for inspecting engines and their individual rotating parts under service conditions and in the experimental design stage. B J

A77-11606 Magnetic particle inspection of aviation engine vanes A G Aleksandrov and S G Shelikhov (*Defektoskopiia*, Jan-Feb 1976, p 81-85) *Soviet Journal of Nondestructive Testing*, vol 12, no 1, Nov 1976, p 62-65 Translation

Consideration is given to the reason for the decrease in revealing fine fatigue cracks in aviation engine vanes in inspection in an electromagnet. Recommendations for inspection methods are given. Compositions of magnetic suspensions and methods of interpretation are shown. (Author)

A77-11625 'C22', the new French target drone ('C22' nouvel engin cible français) P Langereux *Air et Cosmos*, vol 14, Oct 23, 1976, p 24, 25 In French

The C22 is a subsonic, remotely controlled, target drone, of variable speed. It is to replace the target drones of the type CT20. It is expected that the mass production of the C22 will begin in 1981. The target drone is to be propelled by the turbojet engine TRI 60 which is also to be used in remotely piloted vehicles. The C22 will be employed with a towed target for gunnery-training exercises of antiaircraft artillery and for tests conducted with surface to air missiles. The C22 will be able to attain a speed of 0.95 Mach. G R

A77-11712 # Measurement of wake vortex strength by means of acoustic back scattering D C Burnham, T E Sullivan (U S Department of Transportation, Transportation Systems Center, Cambridge, Mass.), and L S Wilk (MIT, Cambridge, Mass.) *Journal of Aircraft*, vol 13, Nov 1976, p 889-894 9 refs

A simple acoustic sounder is shown to produce reliable velocity profiles of aircraft wakes at altitudes below 50 m. Data collection during normal airport landing operations was feasible because the sensor does not intrude into the airspace being measured. A spatial scan through the wake is obtained when the ambient wind transports the wake through the sounder beam. The characteristics of the scattered signals and their spectral densities are presented as intensity modulated CRT displays termed 'Acoustograms'. The data are processed to yield the radial dependence of the velocity and circulation in the wake vortices. The circulation data are fitted to a simple model with two parameters: strength and core radius. The spatial and velocity resolution of the sounder is adequate to measure vortex strength but not to probe details of the core structure. Reliable measurements using this technique are possible only when the vortex transport velocity is well-defined. (Author)

A77-11844 A test facility for aircraft jet noise reduction II B L McGehee (Boeing Commercial Airplane Co., Seattle, Wash.) *Journal of Environmental Sciences*, vol 19, Sept-Oct 1976, p 20-28 24 refs

An overview is given of the design and performance of the Boeing large test chamber (LTC) and subsystems for studying abatement of aircraft jet noise. Support systems for the LTC facility, the anechoic room, acoustic calibration problems, data handling, support systems and test rigs are described at length. Acquisition of reliable aircraft noise performance test data and isolation of LTC noise and surrounding community noise are singled out as the key problems. Measures to keep outside community noise from intruding into the test arena, and preventing LTC noise from causing a nuisance in the surrounding community area are detailed. Test area sizing, flow visualization, the development model chamber, a model propane burner, exhaust stack, pumps, room ventilation, air supplies, cooling water, safety measures, and future LTC facility needs are dealt with. R D V

A77-11887 Laser air-jet engine A I Barchukov, F V Bunkin, V I Konov, and A M Prokhorov (Akademiia Nauk SSSR, Fizicheskii Institut, Moscow, USSR) (*ZHETF Pis'ma v Redaktsiiu*, vol 23, Mar 5, 1976, p 237-240) *JETP Letters*, vol 23, Mar 5, 1976, p 213-215 6 refs Translation

A scheme is outlined for a laser air jet engine (LAJE), in which jet thrust is obtained by optical discharges in the engine caused by a pulsed radiation beam generated on earth. Pulsed optical breakdowns create pulsed shock waves, which are reflected off a surface, impelling the vehicle. Some basic parameter calculations have been performed for different pressure chamber configurations, to gain an idea of required laser performance for a given thrust level. P T H

A77-12000 VTOL RPVs - A technology assessment B Lindenbaum *American Helicopter Society, Journal*, vol 21, Oct 1976, p 29-39

Military uses and advantages of VTOL remotely piloted vehicles (RPV) and VTOL RPV development problems are discussed, along with the state of the art, means of RPV recovery and launch, and numerous VTOL concepts. The higher unit cost of VTOL systems is measured against the total system costs for non-VTOL craft (including landing field or aircraft carrier construction costs and operating costs, ground transportation costs, accident rates), and VTOL advantages where no design accommodation for onboard crew is needed are emphasized (including feasibility of tail-sitter designs, size, availability of all known VTOL approaches). VTOL concepts considered and compared for RPV application include jet lift, augmented thrust (with lift fan and ejector type flow augmenters), shrouded propeller/fans, open propeller/rotor, and VATOL (vertical attitude TOL tail-sitter configuration). R D V

A77-12069 Maintaining transport aircraft R Krahenbuhl (Swissair AG, Kloten, Switzerland) *Esso Air World*, vol 28, no 4, 1976, p 90-93

The article surveys Swissair maintenance practice at Zurich airport, covering the integration of existing computer maintenance programs, programs of periodic checks, and a rundown of maintenance theory for wide-body craft. Hard time maintenance, on condition maintenance, and condition monitoring are defined and contrasted, fail safe and safe life options are defined and their ranges of validity are stated, and the maintenance decision diagram adopted in 1970 is outlined. The computerized automatic test equipment, built in test equipment, and aircraft integrated data system are sketched. Periodic checks, from service check after each flight through checks scheduled for 270 and 1500 flight hours to the heavy maintenance visit (after 12,000 flight hours), are indicated. Physical inspection methods, time allocations in maintenance tasks, and cooperation in maintenance pooling between various carriers are mentioned. R D V

A77-12114 Concorde Endurance flights results (Concorde - Resultats des vols d'endurance) P Lebouc (La Concorde, Toulouse, France) *L'Aéronautique et L'Astronautique*, no 60, 1976, p 10-15. In French

Data are presented and tabulated on Air France Concorde runs through endurance tests to date. Data on each aircraft tested, on the flights executed, the routes traveled, amount of fuel consumed, amount of fuel taken on board, flight profiles, prescheduled detours, and test facilities placed on board for the endurance tests are included. Time out of service during this period is compared to figures for subsonic large aircraft. It is concluded that Concorde has proved itself as an operationally viable passenger aircraft. R D V

A77-12115 Concorde maintenance as seen by the designer - The maintenance program (La maintenance de Concorde vue du côté constructeur - Le programme d'entretien) P Gavin (La Concorde, Paris, France) *L'Aéronautique et L'Astronautique*, no 60, 1976, p 17-33. In French

Preventive maintenance measures for Concorde are presented and it is pointed out that no special problems occur. Emphasis is laid on routine preventive maintenance procedures. Some modes of maintenance are distinguished, parties directly interested in organization of maintenance (airline, aviation officials, and designers) are indicated, and examples of maintenance documentation are presented. Structural analysis, analysis by zones, and analysis based on aircraft, equipment, and motor systems are contrasted. Organization of the maintenance data bank is sketched. Emergency repair procedures and inspection frequency are discussed briefly. R D V

A77-12116 Reliability applied to landing gear and hydraulics (La fiabilité appliquée aux atterrisseurs et à l'hydraulique) M Woerner (Messier-Hispano SA, Service Fiabilité, Montrouge, Hauts-de-Seine, France) *L'Aéronautique et L'Astronautique*, no 60, 1976, p 63-70. In French

Malfunction analysis and assessment, reporting and documentation, and acquisition and treatment of fault data are discussed for civil aviation landing gears and hydraulics systems, on the basis of Messier-Hispano practice. Various levels of readily diagnosed and hidden faults are considered, and tables and branching trees of fault diagnostic tests (for mistimed landing gear actuation) are displayed. Leakage of hydraulic fluid and seizing of equipment parts are also treated. An outline of fault data reporting procedure and fault coding procedure is presented, along with a sample fault report sheet. R D V

A77-12175 # Dynamic-stress-data management for aeromechanical testing of turbomachinery W J Rakowski (ARO, Inc., Arnold Air Force Station, Tenn.) *Society for Experimental Stress Analysis, Spring Meeting, Silver Spring, Md., May 9-14, 1976, Paper 26 p*

The aeromechanical test programs described were initiated to provide experimental data concerning specific turbine engine structural problems and general characterization of turbine engines. Test techniques and data acquisition/processing analysis techniques were developed during these test programs to meet the program requirements. The present paper deals with the data management philosophy and techniques developed for the dynamic strain-gauge data acquired during the programs. The transition from single channel analog analysis equipment to the incorporation of digital computers for aiding on-line data monitoring, bulk processing of test data, and rapid analysis of test results is discussed. The present on-line monitoring and post test processing/analysis systems are described, and refinements for improving the on line data monitoring and post test data processing capabilities are noted. V P

A77-12176 # System considerations for reliable strain data from gas turbine engines D L Willis (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.) *Society for Experimental Stress Analysis, Spring Meeting, Silver Spring, Md., May 9-14, 1976, Paper 17 p*

This discussion will consider the problems of dynamic strain gage installations on the high pressure turbine rotor of a typical twin-spool gas turbine engine. The hostile environment of high temperatures, centrifugal loads and very limited physical space are defined and the total system elements to meet these requirements are described. Some of the elements considered in the system are choices available for the strain gage, means of attachment to the test part, and the lead wire system between the strain gage and the signal transfer device. Special attention is given to the unique wire routing problems associated with the gas turbine engine. The available choices for signal transfer devices are also discussed with a summary of advantages and limitations for various systems. (Author)

A77-12181 # Estimating procedures associated with aircraft modifications J A Knagg (E-Systems, Inc., Dallas, Tex.) *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1101 11 p*

Modification of existing or obsolescent aircraft is discussed from the viewpoint of the weight engineer. Several examples of modified aircraft are described, and a general modification methodology is outlined. Consideration is given to the use of micromodules in aircraft electronic systems, antenna miniaturization, and effects of modification programs on fuel requirements and management. F G M

A77-12182 # Fuselage analytical weight estimation method A D G Bayly (Lockheed California Co., Burbank, Calif.) *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1102 20 p*

Much time and energy has been spent into the investigation of fuselage weight prediction methods. Most of these methods have been established by the use of statistical data derived from past and existing aircraft. A more accurate and convenient method is required for use during the contract definition phase of a program where more detailed information is readily available to the weight engineer. This paper presents an analytical method of weight prediction for the

basic shell of any fuselage. It assumes that the shear loads are absorbed by the skin and stringers and the bending loads are taken out by frames and longerons. Basic loads are required to be known in order to determine the shear and bending material of the shell structure. The method also takes into account cutouts, pressurization and shape penalties. The resulting basic shell weight can then be used along with statistical data for specific design features to arrive at a total fuselage weight. (Author)

A77-12183 # Weight and balance considerations in the design of the A-10A close air support aircraft. G C Leavy (Fairchild Republic Co., Farmingdale, N Y) *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1104* 30 p

This paper describes the design features included in the A-10A Close Air Support Aircraft which had a significant effect on the aircraft weight and balance. Particular attention is given to the survivability features and to the 30 MM gun installation, which are peculiar to the A-10 and had the greatest effect on the weight and balance. Included are quantitative assessments of the first order weight increments due to the design features as well as discussions of the effects of these design features on the configuration and size of the aircraft. (Author)

A77-12184 # Advanced design composite aircraft, the next step for composites. P Schwartz (Grumman Aerospace Corp., Bethpage, N Y) *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1105* 13 p. Contract No. F33615-75-C-3124

The Advanced Design Composite Aircraft (ADCA) program was initiated to define the benefits and effects of unrestrained application of composite materials to a completely new aircraft. The present paper deals with the first phase of the ADCA program whose aim was to define criteria and requirements affecting ADCA design. This phase included parametric tradeoff studies conducted to identify the preferred aircraft configuration and also the weight savings compared with an equivalent metal counterpart. The Supersonic Penetration Interdiction Fighter mission was chosen because it provides the most demanding set of requirements and yields the maximum potential payoff from the unrestrained use of composite materials. Configurations capable of performing the desired mission were evaluated using Grumman's RAVES sizing programs. The resulting smaller and lighter aircraft was found capable of performing the same mission as its metal counterpart. V P

A77-12191 # A method for estimating the weight of aircraft transmissions. A H Schmidt (Boeing Vertol Co., Philadelphia, Pa.) *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1120* 24 p

In the design phase of vertical take-off aircraft, it is necessary to estimate the weight of the transmissions in the drive system as accurately as possible since it comprises a significant portion of the total aircraft weight. A method of determining transmission weight is presented based upon the size of the gears in the transmission. The gear size is not used directly to derive the weight, instead, the more easily obtained values of surface compressive stress index, design horsepower, and gearbox input speed are used along with various factors for special features, etc. Also included are the weight effects of bearing supports, output shaft, combining stages of gearing and special features such as clutches. The use of graphs enables the rapid selection of the factors needed for the application of this weight determination method. A technique for deriving the weight of accessory gearboxes is also presented, along with several examples of the application of the weight estimating method for typical gearboxes. A plot of the statistical accuracy of this method is also presented. (Author)

A77-12194 * # Application of advanced technology to future long-range aircraft. O E Schrader (NASA, Langley Research Center, Hampton, Va.) *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1126* 45 p 9 refs

The objective of this paper is to provide an overview assessment of three separate programs at Langley Research Center that have incorporated advanced technology into the design of long-range passenger and cargo aircraft. The first technology centers around the use of an span-loaded cargo aircraft with the payload distributed along the wing. This concept has the potential for reduced structural weights. The second technology is the application of laminar flow control (LFC) to the aircraft to reduce the aerodynamic drag. The use of LFC can reduce the fuel requirements during long-range cruise. The last program evaluates the production of alternate aircraft fuels from coal and the use of liquid hydrogen as an aircraft fuel. Coal-derived hydrogen as an aircraft fuel offers both the prospect for reduced dependence on petroleum fuels and improved performance for long-range aircraft. (Author)

A77-12195 # The next-generation subsonic transport. D P Marsh (Douglas Aircraft Co., Long Beach, Calif.) *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1127* 8 p

The design approach used at McDonnell Douglas to satisfy the market requirements and operating economics for a next-generation commercial subsonic transport is discussed. The principal near-term design objectives are reduced fuel consumption and the development of a configuration, to satisfy this goal, on the basis of wing geometry studies, advanced technology applications, and fuselage and engine configuration studies. The results of the configuration development studies, marketing reports, and airline inputs indicate that the next-generation transport will incorporate the following features: all-new wing design with higher aspect ratios for reduced drag, advanced high-lift systems for reduced noise and wing area, incorporation of such advanced technologies as supercritical wing, composite materials, and relaxed static stability to reduce fuel consumption and weight, reduced passenger capacity over current wide-body transports to meet market requirements, reduced cruise speed for minimum operating costs, and commonality with existing transport aircraft to reduce development costs. V P

A77-12201 # Aircraft loadability parameters - Some results of an airline survey. N J Carraway (Lockheed-California Co., Burbank, Calif.) *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1146* 12 p

A survey was conducted to obtain current information from commercial airlines regarding those items which affect load flexibility. A summary is presented of the data obtained to date. These data are being used to aid the development of a method for optimizing the initial construction of a design center-of-gravity envelope for commercial aircraft. F G M

A77-12202 # Operational mass properties data for military aircraft - Data formulation, presentation and usage. T Dills (General Dynamics Corp., Fort Worth, Tex.) *Society of Allied Weight Engineers, Annual Conference, 35th, Philadelphia, Pa., May 24-26, 1976, Paper 1147* 56 p

A77-12206 Structural tests of aerodynamic surfaces - A systems approach to analysis and design. K Goldenberg (Albany Medical College, Albany, N Y.) *Journal of Testing and Evaluation*, vol. 4, Nov. 1976, p. 418-424 7 refs

One of the primary tasks in structural ground testing of aerodynamic surfaces is to resolve complex, curvilinear pressure fields into applied test loads. A systems approach is presented which optimally performs this analysis and integrates it with major subsequent phases of the engineering operation specifically, correlation of actual/theoretical shear and moment curves, selection of loading pad geometry, test fixture analysis, and graphical display of the results. Computer programs are available to calculate these results rapidly using curve fitting and statistical methods modified for test data evaluation (Author)

A77-12218 **Lifting-surface theory of straight cascades of swept blades** A F Falcão (Instituto Superior Técnico, Lisbon, Portugal) *International Journal of Mechanical Sciences*, vol 18, no 6, 1976, p 313-320 17 refs. Research supported by the Instituto de Alta Cultura

Lifting-line and lifting-surface expressions are derived for the steady irrotational incompressible flow through a straight cascade of swept blades of finite length and constant loading along the span, the main object being to study the three-dimensional perturbations arising from the presence of the end walls and to determine the warped shape of the blade camber surface. The blade axis is taken perpendicular to the blade-to-blade direction, as an approximation to conical flow with radially set blades. The solution, in terms of the velocity potential, is based on the author's analytical expressions for cascades of unswept blades of varying circulation along the span. Numerical results are presented for a wide range of cascade geometries, and the effects of several cascade parameters upon the wall-induced three-dimensional perturbations are discussed. In particular, it has been found, for most geometries used in practice, that a good approximation is obtained by superposing the disturbances due to the two walls separately (Author)

A77-12428 * **The stochastic control of the F8C aircraft using the multiple model adaptive control/MMAC/ method** M Athans, K-P Dunn, C S Greene, W H Lee, N R Sandell, Jr, I Segall, and A S Willsky (MIT, Cambridge, Mass) In Conference on Decision and Control, 6th, and Symposium on Adaptive Processes, 14th, Houston, Tex., December 10-12, 1975, Proceedings

New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p 217-228 15 refs. Grants No NGL-22-009-124, No NSG 1018, No AF AFOSR-72-2273

The purpose of this paper is to summarize results obtained for the adaptive control of the F-8C aircraft using the so-called MMAC method. The discussion includes the selection of the performance criteria for both the lateral and the longitudinal dynamics, the design of the Kalman filters for different flight conditions, the 'identification' aspects of the design using hypothesis testing ideas, and the performance of the closed loop adaptive system (Author)

A77-12444 **Optimal control for the rolling pullout maneuver of a modern fighter aircraft** G Satyanarayana, U R Prasad, and I G Sarma (Indian Institute of Science, Bangalore, India) In Conference on Decision and Control, 6th, and Symposium on Adaptive Processes, 14th, Houston, Tex., December 10-12, 1975, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p 443, 444

Optimal control laws for the elevator and ailerons of a modern fighter aircraft in a rolling pullout maneuver are obtained to determine the limiting performance. In the analysis, a five-degree-of-freedom model is employed which incorporates many physical phenomena peculiar to the maneuver and also takes account of various disturbance products. Necessary conditions for optimality are derived, and the problem is solved by the conjugate-gradient method for three sets of flight conditions. The results show that the roll rate should be about 250 deg/sec, the maximum normal acceleration should not exceed 5 g's, the minimum time required for

the maneuver is less than 1 sec, the ailerons must be reversed at some stage so that the roll rate becomes zero when the aircraft has rolled through the desired angle, and the elevator deflection should be maximum at the end of the maneuver since the normal acceleration must be maximum only at the end F G M

A77-12448 **On the identification of state-derivative-coupled systems** J M Mendel (Southern California, University, Los Angeles, Calif) In Conference on Decision and Control, 6th, and Symposium on Adaptive Processes, 14th, Houston, Tex., December 10-12, 1975, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p 529-533 8 refs. NSF Grant No GK-41482

A description is given of a sequence of tests for establishing the identifiability of structural parameters which are associated with a given structural state equation, from reduced form parameters, which are associated with a reduced form state equation. A test involving the determination of the rank of a matrix is developed to make a use of either structural parameters or reduced form parameters possible. The application of the identifiability tests is illustrated with the aid of an example G R

A77-12452 **The pursuit-evasion problem of two aircraft in a horizontal plane** N Rajan and U R Prasad (Indian Institute of Science, Bangalore, India) In Conference on Decision and Control, 6th, and Symposium on Adaptive Processes, 14th, Houston, Tex., December 10-12, 1975, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p 635, 636 5 refs

The pursuit-evasion problem of two aircraft in a horizontal plane is modeled as a zero-sum differential game with capture time as payoff. The aircraft are modeled as point masses with thrust and bank angle controls. The games of kind and degree for this differential game are solved (Author)

A77-12455 **R & D project cost and schedule realism - A risk analysis approach** D C Borgman (U S Army, Air Mobility Research and Development Laboratory, St Louis, Mo) and J D Hwang (U S Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif) In Conference on Decision and Control, 6th, and Symposium on Adaptive Processes, 14th, Houston, Tex., December 10-12, 1975, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p 731-733 5 refs

All project managers strive for cost and schedule realism. The Department of the Army has established a novel concept called the 'Total Risk Assessing Cost Estimate (TRACE)' to develop a new program cost-estimation procedure for research, development, test and evaluation cost realism. Such a procedure properly accommodates program uncertainties/risks inherent to specific work elements, and the high-risk work elements are budgeted accordingly. The purpose of this paper is to propose such a procedure which subscribes to a risk analysis approach and satisfies the essential elements of the TRACE concept. The procedure consists of two models: a cost impact model and a schedule variance model. Applications of the procedure to the NASA/Army Tilt Rotor Research Aircraft Project are also presented for illustration (Author)

A77-12460 **Application of Liapunov model - Tracking parameter identification for the CH-47 helicopter** R L Carroll (South Carolina, University, Columbia, S C) In Conference on

Decision and Control, 6th, and Symposium on Adaptive Processes, 14th, Houston, Tex., December 10-12, 1975, Proceedings
New York, Institute of Electrical and Electronics Engineers, Inc., 1975, p 858-863 7 refs

This paper reports results obtained in an evaluation study of model-tracking parameter identification for the optimally controlled CH-47 helicopter while in flight. The model is made to track some of the helicopter parameters by means of Liapunov-designed adaptive algorithm. The topics investigated include the accuracy of identification of the time-varying vehicle and the effect of controller feedback upon the performance of the identifier (Author)

A77-12470 New orientations of intergovernmental organizations of civil aviation (Nouvelles orientations des organismes intergouvernementaux d'aviation civile) M G Folliot (Paris II, Université, Paris, France) *Revue Française de Droit Aérien*, vol 30, July-Sept 1976, p 313-321 13 refs In French

Political, economic, and legal changes in international civil aviation relations are discussed with particular reference to the International Civil Aviation Organization. The politicization of aviation organizations whose function was formerly to deal with technical problems is considered. The problem of regionalism is examined in its two aspects of cooperation and competition. The attitudes of individual states to such questions as legal organization, and fares are discussed B J

A77-12472 Responsibilities and assurances with regard to cargo transport - Air transport law (Responsabilités et assurances en matière de transports de marchandises - Droit applicable spécialement en matière de transport aérien) R R Nys (Bruxelles, Université Libre, Sabena S A, Brussels, Belgium) *Revue Française de Droit Aérien*, vol 30, July-Sept 1976, p 329-344 In French

The paper examines the competition of internal state laws and international conventions in the field of air transport of cargo. Attention is given to the Warsaw Convention of 1929, the Convention of Brussels of 1924, the protocol signed at the Hague in 1955, and the protocol of Guatemala of 1971 B J

A77-12502 Equation solution accuracy in calculating jet engine characteristics A M Akhmedzianov, S Kh Aksel'rod, and Kh S Gumerov (*Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 5-10) *Soviet Aeronautics*, vol 19, no 1, 1976, p 15 5 refs Translation

The calculation of engine characteristics is conventionally reduced to ensuring an accurate selection of the position of the operating point on the characteristic curve of the compressor. In the present paper, a method is proposed for determining the accuracy to which the selection conditions are satisfied for solving a system of equations in the computation of the characteristics of a turbojet engine. It is shown that to achieve convergence of the solution to this system of equations by computer-aided selection (at a prescribed accuracy of such output parameters as thrust and fuel consumption), a specific relation must be used to determine the error in the selection conditions. This relation must be precisely satisfied in the computer-aided determination of the turbojet engine characteristics V P

A77-12503 Air-cooled turbine cascade effectiveness criterion E N Bogomolov (*Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 11-20) *Soviet Aeronautics*, vol 19, no 1, 1976, p 6-12 10 refs Translation

It is proposed to use a parameter that indicates the possible relative increase in kinetic energy behind the blading caused by a

blade-temperature drop as the efficiency criterion for an air-cooled turbine cascade. The criterion takes into account the influence of cooling on the gasdynamic characteristics of the cascade. Cascades with internal cooling and with film cooling of the blade trailing edge are compared, and methods of evaluating analytically the efficiency of such cascades are examined. Relations are derived for calculating the efficiency of trailing-edge cooling with allowance for heat input from the butt end of the trailing edge V P

A77-12504 Off-design regimes of asymmetric nozzles with supersonic inlet velocity L M Vetlutskaia, V N Zudov, and V V Zatuloka (*Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 21-27) *Soviet Aeronautics*, vol 19, no 1, 1976, p 13-17 5 refs Translation

The flow in plane asymmetric nozzles of different geometry is analyzed for the case of a variable supersonic velocity at the nozzle inlet. The thrust characteristics of nozzles of fixed geometry and of optimal nozzles of identical length are compared for a specific inlet Mach number. The influence of external pressure on the force characteristics of a nozzle is demonstrated V P

A77-12509 Thermal analysis of flight vehicle compartment structure N M Krutova, G B Petrazhitskii, and A M Pylaev (*Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 55-60) *Soviet Aeronautics*, vol 19, no 1, 1976, p 40-44 Translation

A method is proposed for solving systems of heat conduction problems that are interrelated solely by linear inclusion of a set of functional parameters. The solution is reduced to obtaining independent particular solutions to each problem of the system and to subsequent treatment of algebraic equations or linear systems. As an example, the method is applied to the analysis of a steady periodic mode, and also of a general regular mode of the first kind, for the case where N subsystems with strong thermal couplings interact with each other V P

A77-12511 Experimental study of combustion time in two-stage combustion process A V Mosin, O V Stroganov, V A Shchukin, and A V Talantov (*Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 67-70) *Soviet Aeronautics*, vol 19, no 1, 1976, p 50-52 7 refs Translation

The burning process in afterburners of gas turbine engines takes place in mixtures diluted by combustion products. The combustion period in turbulent flows in such mixtures is studied experimentally, showing that the combustion products affect appreciably the combustion period. The empirical relationships obtained are interpreted in terms of the postulates of a 'surface' model of turbulent combustion V P

A77-12513 Selection of compressor pressure ratio of small GTE installed in bypass turbojet engine fan duct B D Fishbein (*Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 78-85) *Soviet Aeronautics*, vol 19, no 1, 1976, p 58-62 9 refs Translation

The problem of determining the pressure ratio that is optimal with respect to thrust for the compressor for a small-scale gas-turbine engine in the bypass duct is analyzed. The compressor pressure ratio is plotted against the pressure ratio of the fan, against the gas temperature in front of the turbine of the small-scale engine, and against the parameters of the engine inlet. It is shown that a pressure ratio between 4 and 5 provides optimal thrust characteristics V P

A77-12515 Penetration and mixing of liquid injected into supersonic transverse gas stream Z G Shakhutdinov and V M Klevanskii (*Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 99-108)

Soviet Aeronautics, vol 19, no 1, 1976, p 74-80 7 refs Translation

Photographic methods do not yield correct quantitative relationships in studies of secondary flows propagating in a cross-wind. The 'thermometric' method proposed makes it possible to study the spatial dispersion boundaries of the injected fluid and the mixing characteristics of the injected stream. The penetration depth, the shape of the cross section, and the mixing characteristics are plotted for water jets injected at pressures of 4 to 80 bars into gas flow of Mach number 2.5 and a temperature of 500 K. V P

A77-12517 Heat transfer in tube entrance segment with initial flow swirl and transverse injection. V K Shchukin, A A Khalatov, and A V Kozhevnikov (*Aviatsionnaya Tekhnika*, vol 19, no 1, 1976, p 115-121) *Soviet Aeronautics*, vol 19, no 1, 1976, p 86-90 8 refs Translation

A77-12520 Study of flow swirl influence on axial diffuser effectiveness. I G Gogolev, A M Dronov, and V M Sivaev (*Aviatsionnaya Tekhnika*, vol 19, no 1, 1976, p 132-135) *Soviet Aeronautics*, vol 19, no 1, 1976, p 102-105 Translation

The economic efficiency of gas turbine units can be improved by using an exit cone that will operate efficiently over a range of turbine modes. If, however, the mode of operation of the preceding stage is changed, the flow conditions at the diffuser inlet, in particular, the flow direction, will also change. The wind-tunnel study described was aimed at studying the influence of swirl on the economic efficiency of mixed-flow diffusers with an expansion ratio of 1.8. The diagrammed results of the study are discussed. V P

A77-12521 Determination of magnitudes of the parameters characterizing ducted air scoop operation downstream. B L Zel'dovich, L M Kotliar, and E D Nesterov (*Aviatsionnaya Tekhnika*, vol 19, no 1, 1976, p 136-140) *Soviet Aeronautics*, vol 19, no 1, 1976, p 106-110 8 refs Translation

The impingement of a nozzle jet against the endplate of an external target type thrust reverser is analyzed with the framework of the theory of ideal fluid jets. Specifically, the two-dimensional problems of the impingement of an ideal incompressible jet expelled from a semi-infinite nozzle with straight parallel walls onto two plates arranged symmetrically with respect to the channel axis is solved by the method of singular points. A relationship between the geometrical and physical parameters of the problem is established. V P

A77-12522 Analytic and experimental study of turbine rotor blade temperature. K M Isakov, A A Pantelev, V A Trushin, and V N Fedorov (*Aviatsionnaya Tekhnika*, vol 19, no 1, 1976, p 141-146) *Soviet Aeronautics*, vol 19, no 1, 1976, p 111-115 7 refs Translation

A numerical finite-difference scheme is proposed for calculating the thermal state of turbine blades with a transverse cooling-air flow. The technique can be used to determine the temperature distributions over the blade contour and over the wall thickness of the blade, and the behavior of the cooling-air temperature along the path from the leading edge to the exit slot at the trailing edge. The theoretical results are found to correlate with thermocouple and pyrometer measurements. V P

A77-12528 Heat-pipe regenerator for gas turbine engine. V K Shchukin, I I Mosin, N V Lokai, and I I Fedorov (*Aviatsionnaya Tekhnika*, vol 19, no 1, 1976, p 172-175) *Soviet Aeronautics*, vol 19, no 1, 1976, p 140-143 Translation

The principles of operation of gas-turbine-engine regenerator of a fundamentally new design are discussed. The device is essentially a

recuperative (fixed) heat exchanger which uses heat pipes to offset the intrinsic drawbacks of recuperative heat exchangers, such as a low recovery factor and high hydraulic pressure losses along the hot gas duct. V P

A77-12551 Computational methods and problems in aeronautical fluid dynamics. Edited by B L Hewitt (British Aircraft Corp., Ltd., Weybridge, Surrey, England), C R Illingworth (Manchester, Victoria University, Manchester, England), R C Lock (Royal Aircraft Establishment, Farnborough, Hants., England), K W Mangler (Southampton, University, Southampton, England), J H McDonnell (British Aircraft Corp., Ltd., Weybridge, Surrey, England), C Richards (Institute of Mathematics and its Applications, Southend-on-Sea, Essex, England), and F Walkden (Salford, University, Salford, Lancs., England). London and New York, Academic Press, 1976. 536 p. \$29.75

The papers collected provide a review of recent developments in numerical solution techniques for aeronautical flows. Some papers review basic techniques as well, while others present new concepts for specific problems. Topics covered include methods for elliptic problems in external aerodynamics, compressible subcritical flow through axially symmetric sharp-lipped orifices and nozzles, finite element and difference methods for cascades, problems of unsteady flow past aircraft, an extended integral equation method for the unsteady transonic flow past a two-dimensional airfoil, relaxation near a sonic line, steady supersonic flowfields with embedded subsonic regions, and numerical solution of turbulent swirling flows. P T H

A77-12552 Practical requirements in industry. H Hitch (British Aircraft Corp., Ltd., Weybridge, Surrey, England). In: Computational methods and problems in aeronautical fluid dynamics. London and New York, Academic Press, 1976, p 1-14. 6 refs

The present procedure of potential flow solutions and general boundary layer calculations for aircraft aerodynamic calculations is a makeshift procedure that contains no real statement about separation, drag, buffet, or sensitivity of the design to these phenomena, and moreover, the boundary layer calculations are only two-dimensional. For modern aircraft, especially those featuring supercritical wings, computational methods are required that produce reliable drag estimates for three-dimensional, compressible, viscous flows over real geometries, in which separation and shock conditions are produced in the process. Wind tunnels for the Reynolds number range 20 to 40 million will be required, along with computers of greater performance than present ones. P T H

A77-12554 Methods for elliptic problems in external aerodynamics. R C Lock (Royal Aircraft Establishment, Farnborough, Hants., England). In: Computational methods and problems in aeronautical fluid dynamics. London and New York, Academic Press, 1976, p 53-99. 24 refs

The paper reviews some of the more important methods for calculating the inviscid, incompressible, subsonic flow past aerodynamic bodies. The most efficient methods of solution are obtained by representing the flow by a distribution of singularities - sources, doublets, or vortices - placed either on or inside the body and also, for lifting systems, on the vortex wake behind it. Considerable attention is given to the panel method for incompressible flows. For two-dimensional compressible flow, a conformal mapping technique with finite-difference approximation is described. P T H

A77-12555 Compressible subcritical flow through axially symmetric sharp-lipped orifices and nozzles G M Alder (Edinburgh, University, Edinburgh, Scotland) In Computational methods and problems in aeronautical fluid dynamics London and New York, Academic Press, 1976, p 100-116 16 refs

The paper describes a finite difference method for the solution of irrotational axially symmetric subcritical flows of an ideal gas through conical nozzles Transformation to hodograph coordinates maps the whole flowfield into a rectangle and allows a rectangular finite difference mesh to be used The error in the solution may be estimated by considering different mesh node densities Typical results for both axially symmetric and two-dimensional flows are given P T H

A77-12556 Subsonic flows in turbomachines H Marsh (Durham, University, Durham, England) In Computational methods and problems in aeronautical fluid dynamics London and New York, Academic Press, 1976, p 117-139 22 refs

The paper discusses the basic mathematical model for the flow in turbomachines as developed by Wu for a single cascade The discussion concentrates on the two main methods for solving the governing equations, the method of streamline curvature and the through-flow analysis involving finite differences, for calculating the flow on a mean blade-like surface between two blades The relationship between the two methods is discussed together with their limitation on Mach number Some areas where the techniques need further refinement are indicated, such as transonic flows, unsteady flows, the use of a consistent loss model, wall boundary layers, and secondary flows P T H

A77-12557 Finite element and difference methods for cascades M J O'Carroll and L A Morgan (Lanchester Polytechnic, Coventry, England) In Computational methods and problems in aeronautical fluid dynamics London and New York, Academic Press, 1976, p 140-157 14 refs

The paper is concerned with finding rapid iterative techniques for linearized flow problems on skew nets as arise in the numerical solution of the three dimensional steady, inviscid, incompressible blade-to-blade cascade flow Comparisons are made between finite element and finite difference techniques, with a test cascade of known exact solution being used to demonstrate the discretization accuracy of the methods The two methods are compared for block successive overrelaxation performance on a skewed net The element equations take about three times longer to assemble than the comparable difference equations, and convergence of iterations is of similar speed Optimal convergence is guaranteed for the element equations, but not for the difference ones The two methods give results of similar discretization accuracy, but the element method lends itself more easily to local net refinement P T H

A77-12558 The finite element method applied to fluid mechanics J H. Argyris and P C. Dunne (Stuttgart, Universität, Stuttgart, West Germany) In Computational methods and problems in aeronautical fluid dynamics London and New York, Academic Press, 1976, p. 158-197 21 refs.

The paper reviews the basic properties of the main types of elements used in finite element computations, and then presents some examples of the use of the finite element technique in basic fluid dynamics problems The simplest type of problem is one with positive definite quadratic forms, illustrated by plane incompressible flow in a duct A simple membrane analogy and a more complex plate analogy from solid mechanics are developed for an incompressible potential flow problem and the problem of Stokes flow.

P T H

A77-12559 Free vortex sheets. K W Mangler (Southampton, University, Southampton, England) In Computational methods and problems in aeronautical fluid dynamics 12551 02-02) London and New York, Academic Press, 1976, p 198-213 18 refs

The paper is concerned with the analysis of the shape and strength of the vortex sheet which is shed from the trailing edge of a slender delta wing or from a lifting wing at incidence For the delta wing, the pressure condition on the vortex sheet is nonlinear, and the problem is essentially two-dimensional. An iterative procedure for the core of the vortex sheet is described For a vortex sheet behind a lifting wing, a doublet source distribution is used, and the panel method is used to perform numerical calculations of velocities

P.T H

A77-12560 Some problems of unsteady flow about aircraft G J Hancock (Queen Mary College, London, England) In Computational methods and problems in aeronautical fluid dynamics London and New York, Academic Press, 1976, p 214-241 15 refs

The paper discusses some methods used to study the problem of aircraft wings in unsteady motion In particular, some of the extensions of the Smith approach to unsteady problems are described Some problems associated with the use of vortex lattice methods for calculating steady and unsteady load characteristics on finite wings are also investigated

P T H

A77-12561 Transonic flows M G Hall (Royal Aircraft Establishment, Farnborough, Hants, England) In Computational methods and problems in aeronautical fluid dynamics London and New York, Academic Press, 1976, p 242-269 26 refs

The paper outlines some of the recent approaches to the problem of mixed flow calculations, giving attention to integral equation methods, the method of integral relaxations, and finite difference methods Closer attention is then given to the relaxation type of finite difference method, which is illustrated by an outline of the solution of the transonic small perturbation equation for the flow past a two dimensional airfoil Developments and extensions of the basic relaxation method are then considered, and shortcomings and remaining problems to be worked on are pointed out

P T H

A77-12562 An extended integral equation method for the steady transonic flow past a two-dimensional aerofoil D Nixon (Queen Mary College, London, England) In Computational methods and problems in aeronautical fluid dynamics London and New York, Academic Press, 1976, p 270-289 12 refs

A77-12563 Relaxation near a sonic line A Roberts (British Aircraft Corp., Ltd, Weybridge, Surrey, England) In Computational methods and problems in aeronautical fluid dynamics London and New York, Academic Press, 1976, p 290-326

The paper is concerned with achieving rapid relaxation over the interfaces between the supersonic and subsonic regions describing the complete transonic flow past a subsonic lifting aircraft The physical plane is regarded as the near field inside a rectangular working section together with the far field The steady isentropic field equation is to be satisfied over the whole physical plane, and the

limiting form of the field equation is the Prandtl-Glauert equation. The nonlinear isentropic field equation is solved indirectly with the aid of elliptic solvers within iterative loops. This gives rapid local convergence where the velocity is near the freestream value. A wall relaxation sequence based on Laplacian field concepts gives rapid convergence when the compressibility effects are small. P T H

A77-12564 A transonic hodograph theory for aerofoil design. J W Boerstol (Nationaal Luchtvaartlaboratorium, Amsterdam, Netherlands). In *Computational methods and problems in aeronautical fluid dynamics*. London and New York, Academic Press, 1976, p. 327-353. 9 refs. Research supported by the Netherlands Agency for Aerospace Programs.

Theory, implementation, and typical results are described for a hodograph method for transonic airfoil design. The method is based on the approximate solution of Tricomi boundary value problems for the mixed elliptic-hyperbolic hodograph equations, where approximation is achieved by a linear combination of solutions of the hodograph equations. Some examples of computed airfoils and their design pressure distributions are shown. P T H.

A77-12565 Supersonic flows. F Walkden (Salford, University, Salford, Lancs., England). In *Computational methods and problems in aeronautical fluid dynamics*. London and New York, Academic Press, 1976, p. 354-382. 13 refs. Research supported by the Science Research Council.

This review paper is concerned with methods and problems associated with the computation of steady flowfields produced when a body is placed in a uniform supersonic stream. Attention is restricted to body shapes such that the effects of viscosity are confined to narrow layers lying close to body surfaces. In these cases good predictions of both surface pressures and flow outside the boundary layers can be obtained by solving equations of motion in which the effects of fluid viscosity are neglected. Distinctive features of numerical methods which have been used successfully to calculate a variety of steady inviscid supersonic flowfields are then examined. Some numerical results are presented. (Author)

A77-12566 Applications of linearised supersonic wing theory to the calculation of some aircraft interference flows. M Purshouse and R K Nangia (British Aircraft Corp., Ltd., Weybridge, Surrey, England). In *Computational methods and problems in aeronautical fluid dynamics*. London and New York, Academic Press, 1976, p. 383-423. 25 refs. Research supported by the British Aircraft Corp.

The Mach box method is used to provide a numerical formulation of linearized supersonic wing theory for calculating some typical aircraft interference flows. In this method, the disturbance regions in a wing plane are overlaid by a grid of rectangular constant source strength Mach boxes, which become square when a coordinate transformation to the equivalent problem at Mach 1.414 is introduced. Flow perturbations produced at a point in the downstream zone from a source are calculated by appropriate aerodynamic influence coefficient relations. In the calculation of an underwing flowfield at a typical intake location, the effect of leading edge droop on the intake flowfield is studied. Other applications are the calculation of the interference field at a fin location arising from asymmetric elevon deflection, and the mutual interference field produced by two 65-deg-sweep delta wings. P T H.

A77-12579 # Application of the time-temperature analogy to the calculation of the total creep of fiberglass plastics in an unsteady temperature field (O primeneni temperaturno-vremennoi

analogii k raschetu deformatsii polzuchesti stekloplastikov v nestatsionarnom pole temperatur) Iu S Pervushin, V P Pavlov, and V V Zainullin (Ufimskii Aviatsionnyi Institut, Ufa, USSR). *Problemy Prochnosti*, July 1976, p. 27-29. In Russian.

A77-12583 # Effect of structural state on the high-temperature long-term strength of molybdenum (Vlianie strukturnogo sostoianniia na vysokotemperaturnuiu dlitel'nuu prochnost' molibdena) N P Drozd, R K Ivashchenko, G G Maksimovich, Iu V Mil'man, N M Sinchenko, and V I Trefilov (Akademiia Nauk Ukrainnoi SSR, IPM, Kiev, Akademiia Nauk Ukrainnoi SSR, Fiziko-Mekhanicheskii Institut, Lvov, Ukrainian SSR). *Problemy Prochnosti*, July 1976, p. 39-43. 26 refs. In Russian.

A77-12630 # Nonlinear analysis of flows generated by the impulsive motion of a wedge (Nelineinyi analiz techeniia, impul'snogo vnezapnogo dvizheniia klina) V V Titarenko. *PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki*, May-June 1976, p. 37-47. 15 refs. In Russian.

The method of matched asymptotic expansions is applied to the analysis of some self-simulating problems concerning the impulsive motion of a wedge. The nature of the wave boundary of a perturbed region is identified. Solutions are obtained which, in the second approximation, describe flows behind weak shock fronts propagating in a gas at rest and behind the fronts of weak discontinuity lines, propagating in certain homogeneous flows. A boundary value problem is formulated, whose solution describes, in the first approximation, flows near points of interaction of fronts. The existence of similarity laws for such flows is demonstrated. V P.

A77-12680 * Two-phase turbine engines. D G Elliott (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Biphase Engines, Inc., Santa Monica, Calif.) and L G Hays (Biphase Engines, Inc., Santa Monica, Calif.). In *Intersociety Energy Conversion Engineering Conference*, 11th, State Line, Nev., September 12-17, 1976, Proceedings Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 222-228. 11 refs. Contracts No. E(04-3)-1228, No. E(04-3)-1207, No. E(04-3)-1255.

A description is given of a two-phase turbine which utilizes a uniform mixture of gas and liquid accelerated in nozzles of the types reported by Elliott and Weinberg (1968). The mixture acts directly on an axial flow or tangential impulse turbine or is separated into gas and liquid streams which operate separately on a gas turbine and a hydraulic turbine. The basic two-phase cycles are examined, taking into account working fluids, aspects of nozzle expansion, details of turbine cycle operation, and the effect of mixture ratio variation. Attention is also given to two-phase nozzle efficiency, two-phase turbine operating characteristics and efficiencies, separator turbines, and impulse turbine experiments. G R.

A77-12778 Survey of hydrogen energy application projects. R E Billings (Billings Energy Corp., Provo, Utah). In *Intersociety Energy Conversion Engineering Conference*, 11th, State Line, Nev., September 12-17, 1976, Proceedings Volume 1. New York, American Institute of Chemical Engineers, 1976, p. 972-977. 17 refs.

Contemporary U.S. hydrogen application research projects are reviewed. Specific emphasis is placed on aircraft, industrial and domestic applications, electrical generation and storage, vehicles, and farms. Although the study does not attempt to evaluate the technical feasibility or status of individual projects, some prognostications are made as to future hydrogen energy applications. (Author)

A77-12872 Design consideration for the Darrieus rotor. R W Thresher and R W Wilson (Ohio State University, Corvallis,

Ohio) In Intersociety Energy Conversion Engineering Conference, 11th, State Line, Nev., September 12-17, 1976, Proceedings Volume 2 New York, American Institute of Chemical Engineers, 1976, p 1787-1794 20 refs Research supported by the Oregon People's Utility Districts Directors' Association, Contract No AT(04-3)-1075

The objective of this study was to determine the performance, operating and load characteristics of Darrieus wind turbines The performance of Darrieus Rotors was examined using the flow model of Wilson and Lissaman The blades of the rotors were assumed to be of a parabolic shape with the vertical height equal to twice the maximum radius Performance curves and operating envelopes for a family of Darrieus Rotors with diameters ranging from 7.62 to 30.49 meters were determined Aerodynamic loads are also presented for various blade positions and operating conditions The rotors have been selected to reach maximum rated shaft power at a wind speed of 8.94 m/s (20 mph) and have a cut-off wind speed of 20.12 m/s (45 mph) A structural analysis of the Darrieus vertical axis wind turbine is also presented The emphasis was placed on obtaining an estimate for the lead-lag bending-torsion stresses and deformations To accomplish this task, a rather elementary model was developed where several simplifying assumptions were used, both a maximum stress based design and a maximum deformation based design were developed (Author)

A77-12927 The technical basis for a national civil aviation research, technology, and development /RT & D/ policy, Proceedings of the Workshop Conference, Crystal City, Va., March 10-12, 1976 Conference sponsored by the American Institute of Aeronautics and Astronautics and National Science Foundation, NSF Grant No C-76-12038 Edited by J Grey (American Institute of Aeronautics and Astronautics, New York, N Y) New York, American Institute of Aeronautics and Astronautics, Inc., 1976 83 p \$8.50

Technology requirements for civil air transportation systems projected for operational status circa 2000 AD are emphasized, with attention also given to developments probably requiring longer lead times Major subject areas are aerodynamics and configurations, structures and materials, propulsion, air operations and ground support technology and organization, airport design and access to terminals, testing and evaluation facilities The entire spectrum of speeds and aircraft flying modes, from subsonic to hypersonic, and including CTOL, STOL, VTOL and QVTOL, new rotorcraft concepts, and hypersonic cruise aircraft, is encompassed in the survey Advances in wind tunnels, materials technology, nondestructive evaluation techniques, crashworthiness, and development of alternative fuels and fuel consumption reduction are also dealt with R D V

STAR ENTRIES

N77-10001* National Aeronautics and Space Administration Langley Research Center Langley Station Va
WINGTIP VORTEX DISSIPATOR FOR AIRCRAFT Patent
 James C Patterson Jr, inventor (to NASA) Issued 5 Oct 1976
 6 p Filed 28 May 1974 Supersedes N74-26456 (12 - 16 p 1855)

(NASA-Case-LAR-11645-1 US-Patent-3 984 070
 US-Patent-Appl-SN-473973 US-Patent-Class-244-130
 US-Patent-Class-244-113) Avail US Patent Office CSCI 01A

A means for attenuating the vortex created at aircraft wingtips which consists of a retractable planar surface transverse to the airstream and attached downstream of the wingtip which creates a positive pressure gradient just downstream from the wing is presented. The positive pressure forces a break up of the rotational air flow of the vortex. Official Gazette of the US Patent Office

N77-10003*# Washington Univ St Louis Mo Dept of Mechanical Engineering

ROTOR DYNAMIC STATE AND PARAMETER IDENTIFICATION, FROM SIMULATED FORWARD FLIGHT TRANSIENTS, PART 1

K H Hohenemser D Banerjee and S K Yin Jun 1976 61 p refs

(Contract NAS2-7613)
 (NASA-CR-137963 Rept-3) Avail NTIS HC A04/MF A01 CSCI 01A

State and parameter identifications from simulated forward flight blade flapping measurements are presented. The transients were excited by progressing cyclic pitch stirring or by hub stirring with constant stirring acceleration. Rotor dynamic inflow models of varying degree of sophistication were used from a one parameter inflow model (equivalent Lock number) to an eight parameter inflow model. The maximum likelihood method with assumed fixed measurement error covariance matrix was applied. The rotor system equations for both fixed hub and tilting hub are given. The identified models were verified by comparing true responses with predicted responses. An optimum utilization of the simulated measurement data can be defined. From the numerical results it can be anticipated that brief periods of either accelerated cyclic pitch stirring or of hub stirring are sufficient to extract with adequate accuracy up to 8 rotor dynamic inflow parameters plus the blade Lock number from the transients. Author

N77-10004*# Washington Univ St Louis Mo Dept of Mechanical Engineering

ROTOR DYNAMIC STATE AND PARAMETER IDENTIFICATION FROM SIMULATED FORWARD FLIGHT TRANSIENTS, PART 2

K H Hohenemser and S T Crews Jun 1976 44 p refs
 (Contract NAS2-7613)

(NASA-CR-137964 Rept-3) Avail NTIS HC A03/MF A01 CSCI 01A

State and parameter identifications based on a form of the maximum likelihood method are applied to the problem of extracting linear perturbation models including rotor dynamic inflow effects from transient blade flapping measurements. The estimation method is first studied in computer simulations and then applied to cyclic pitch stirring transients generated with a four-bladed rotor model operating in hovering trim conditions. The analytical perturbation models extracted from the transient test results are compared with transient and frequency response

tests not used in the state and parameter identification. The identified analytical perturbation model is also compared with a simple theory. The method that is applicable both to small scale and full scale dynamic rotor testing is being extended to perturbations from forward flight trim conditions. Author

N77-10005*# Washington Univ St Louis Mo Dept of Mechanical Engineering

METHODS STUDIES ON SYSTEM IDENTIFICATION FROM TRANSIENT ROTOR TESTS Annual Report, Part 1

K H Hohenemser D Banerjee and S K Yin Jun 1975 125 p refs

(Contract NAS2-7613)
 (NASA-CR-137965 AR-2-Pt-1) Avail NTIS HC A06/MF A01 CSCI 01A

Some of the more important methods are discussed that have been used or proposed for aircraft parameter identification. The methods are classified into two groups. Equation error or regression estimates and Bayesian estimates and their derivatives that are based on probabilistic concepts. In both of these two groups the cost function can be optimized either globally over the entire time span of the transient or sequentially leading to the formulation of optimum filters. Identifiability problems and the validation of the estimates are briefly outlined and applications to lifting rotors are discussed. Author

N77-10006*# Washington Univ St Louis Mo Dept of Mechanical Engineering

ADDITIONAL EXPERIMENTS WITH A FOUR-BLADED CYCLIC PITCH STIRRING MODEL ROTOR, PART 2 OF SECOND YEARLY REPORT

K H Hohenemser and S T Crews Jun 1975 70 p

(Contract NAS2-7613)
 (NASA-CR-137966) Avail NTIS HC A04/MF A01 CSCI 01A

The four bladed pitch stirring rotor model was used in a rotor dynamic wake survey at zero advance ratio covering 2 deg 5 deg and 8 deg collective pitch settings. Dynamic wake data were taken in planes 12 and 20 radii below the rotor disk and are to be compared with analytical wake data with parameters to be identified from pitch stirring transients. The model was modified to perform such transients. The instrumentation developed for this purpose is described together with the method of data acquisition and with the test procedures. The hardware and software for several data handling systems are discussed. These systems extract from pitch stirring transients the parameters of analytical dynamic rotor wake models. Author

N77-10007*# Princeton Univ NJ Dept of Aerospace and Mechanical Sciences

SENSITIVITY OF HINGELESS ROTOR BLADE FLAP-LAG STABILITY IN HOVER TO ANALYTICAL MODELLING ASSUMPTIONS

H C Curtiss Jr Jan 1975 99 p refs Sponsored in part by Army

(Contract NAS2-7615)
 (NASA-CR-137967 AMS-1236) Avail NTIS HC A05/MF A01 CSCI 01A

Prediction of flap-lag stability using a single bending mode for each degree-of-freedom is examined in the case in which the bending modes are assumed to be the same in the flap and lag directions and are independent of pitch angle and stiffness distribution. It is shown that this model gives results analogous to those obtained by Ormiston employing a rigid blade model with the blade and hub stiffness represented by springs in the limiting cases of the elastic coupling parameter $R = 0$ and 1. For intermediate values of R the results are shown to be quite different. The mode shape assumptions are shown to result in what is referred to as the parallel spring model in contrast to Ormiston's model which is referred to as a series spring model. The similarities and differences between these two models are developed in some details. The differences between these two

models are examined for various typical rotor blade characteristics. Other aspects of the sensitivity of this problem are also considered. Author

N77-10008* Princeton Univ NJ Dept of Aerospace and Mechanical Sciences

AN EXPERIMENTAL STUDY OF THE NONLINEAR STIFFNESS OF A ROTOR BLADE UNDERGOING FLAP, LAG AND TWIST DEFORMATIONS Final Technical Report

E H Dowell and J J Traybar Jan 1975 58 p refs Sponsored in part by Army

(Contract NAS2-7615)

(NASA-CR-137968 AMS-1194) Avail NTIS HC A04/MF A01 CSCL 01A

The large deformation of a cantilevered beam under a gravity tip load was studied. The beam root is rotated so that the tip load is oriented at various angles with respect to the beam principal axes. Static twist and bending deflections of the tip and bending natural frequencies were measured as a function of tip load magnitude and orientation. The experimental data are compared with the results of a recently developed nonlinear structural theory and agreement is good for deflections that are small compared to the beam span with systematic deviations for larger deflections. These results support the validity and utility of the nonlinear structural theory for rotor blade applications.

Author

N77-10009* Princeton Univ NJ Dept of Aerospace and Mechanical Sciences

AN EXPERIMENTAL STUDY OF THE NONLINEAR STIFFNESS OF A ROTOR BLADE UNDERGOING FLAP, LAG AND TWIST DEFORMATIONS

E H Dowell and J J Traybar Dec 1975 79 p refs Sponsored in part by Army

(Contract NAS2-7615)

(NASA-CR-137969 AMS-1257) Avail NTIS HC A05/MF A01 CSCL 01A

This is an addendum to an experimental study of the large deformation of a cantilevered beam under a gravity tip load. It adds higher quality and new data on the static twist and bending deflections of the beam. The experimental data are compared with a recently developed nonlinear structural theory. Agreement is good for deflections that are small compared to the beam span and has systematic deviations for larger deflections. Author

N77-10010* Chrysler Corp New Orleans, La Space Div
HIGH SUPERSONIC AERODYNAMIC CHARACTERISTICS OF FIVE IRREGULAR PLANFORM WINGS WITH SYSTEMATICALLY VARYING WING FILLET GEOMETRY TESTED IN THE NASA/LARC 4-FOOT UPWT (LEG 2) (LA45A/B)

Oct 1976 478 p ref

(Contract NAS9-13247)

(NASA-CR-147628 DMS-DR-2297) Avail NTIS HC A21/MF A01 CSCL 01A

An experimental and analytical aerodynamic program to develop pre-design guides for irregular planform wings is reported. The benefits are linearization of subsonic lift curve slope to high angles of attack and avoidance of subsonic pitch instabilities at high lift by proper tailoring of the planform fillet wing combination while providing the desired hypersonic trim angle and stability. The two prime areas of concern are to optimize shuttle orbiter landing and entry characteristics. Basic longitudinal aerodynamic characteristics at high supersonic speeds are developed. Author

N77-10012* Transemanatics Inc Washington D C
MECHANISM OF STABILIZATION OF THE 'SEPARATION POINT' OF A VORTEX DURING FLOW OF A STREAM AT LOW SUBSONIC VELOCITY OVER A DELTA WING

E A Truneva NASA Nov 1976 11 p refs Transl into ENGLISH from Izv Vyssh Ucheb Zaved, Aviats Tekh (USSR), no 2, Feb 1976 p 106-110

(Contract NASw-2792)

(NASA-TT-F-17283) Avail NTIS HC A02/MF A01 CSCL 01A

The mechanism of vortex separation and displacement of the separation point beginning with the development of the separation phenomenon is presented. The results of this research may be valuable for determination of stresses on the wind and investigation of non-stationary aerodynamic characteristics of aircraft with delta wings, in the low velocity region corresponding to takeoff and landing. Author

N77-10013* Lockheed-Georgia Co Marietta
NEW DEVELOPMENTS IN BLOWN FLAP NOISE TECHNOLOGY

John S Gibson 1976 12 p refs Presented at the 10th Congr of ICAS Ottawa 3-8 Oct 1976

(Contract NAS1-13870)

(NASA-CR-145086) Avail NTIS HC A02/MF A01 CSCL 01A

The noise technology relating to blown-flap systems is reviewed. There are three general sources of noise: turbomachinery, airframe, and the interaction noise of the jet blowing on the flaps. The latter noise-source area is the most critical and the main subject discussed. Characteristics of lower surface blown and upper surface blown systems are described, including noise spectra, directivity, jet velocity characteristics, aircraft geometric variation effects, and aircraft forward speed effects. Noise reduction concepts are described, including slowing down the jet flow field by devices and engine cycle modifications, structural geometry and shielding modifications, local flow field modifications of the passive and active type, and the absorption of noise. It is concluded that while there has been considerable progress in the past several years, low noise characteristics in blown flap aircraft must be largely built in by better application of low noise principles during the design. Author

N77-10014* Lockheed-Georgia Co Marietta
NUMERICAL STUDIES OF THREE-DIMENSIONAL BREAKDOWN IN TRAILING VORTEX WAKES

P F Evans and J E Hackett Jun 1976 100 p refs

(Contract NAS2-8651)

(NASA-CR-137888) Avail NTIS HC A05/MF A01 CSCL 20D

Finite element three dimensional relaxation methods are used to calculate the development of vortex wakes behind aircraft for a considerable downstream distance. The inclusion of a self-induction term in the solution dependent upon local curvature and vortex core radius permits calculation of finite lifetimes for systems for which infinite life would be predicted. Two dimensionally, the associated computer program is described together with single-pair, twin-pair, and multiple-pair studies carried out using it. It is found in single-pair studies that there is a lower limit to the wavelengths at which the Crow-type of instability can occur. Below this limit, self-induction effects cause the plane of the disturbance waves to rotate counter to the vortex direction. Self induction in two dimensionally generated twin spiral waves causes an increase in axial length which becomes more marked with decreasing initial wavelength. The time taken for vortex convergence toward the center plane is correspondingly increased. The limited parametric twin-pair study performed suggests that time-to-converge increases with increasing flap span. Limited studies of Boeing 747 configurations show correct qualitative response to removal of the outer flap and to gear deployment as compared with wind tunnel and flight test experience. Author

N77-10017# Office National d'Etudes et de Recherches Aérospatiales Paris (France)

STUDY OF THE SUBSONIC FLOW AROUND A SHARP LEADING EDGE

Gerard Laruelle and Paul Levart Assoc. Aeron et Astronautique de France 1976 23 p refs In FRENCH, ENGLISH summary Presented at the 12th Ecole Natl Super de Méc et d'Aérotech / CEAT Colloq Appl Poitiers France, 5-7 Nov 1975 (AAAF-NT-76-14, ISBN-2-7170-0396-7) Avail NTIS HC A02/MF A01 CEDOCAR, Paris FF 15 (France and EEC) FF 19 (others)

The subsonic flow around a sharp leading edge, resulting from the air intake drag of supersonic aircraft flying at subsonic speeds was studied. The calculation method used is presented and the simulation of leading edge separation is detailed. The experimental setup is presented (S5 wind tunnel at Chalais-Meudon France). The calculated and measured values were compared and found to be satisfactory. An adaptation of the computer program for potential flow by finite differences was attempted. ESA

N77-10019# Aix-Marseille Univ (France) Inst de Mécanique des Fluides

EXPERIMENTAL STUDY OF THE AERODYNAMICS OF A HELICOPTER ROTOR IN TRANSLATIONAL FLIGHT TWO DIMENSIONAL SIMULATION OF THE EFFECTS DUE TO CYCLIC VARIATIONS OF THE VELOCITY VECTOR [ETUDE EXPERIMENTALE RELATIVE A L'AERODYNAMIQUE D'UN ROTOR D'HELICOPTERE EN VOL DE TRANSLATION SIMULATION EN ECOULEMENT PLAN DES EFFETS DUS AUX VARIATIONS CYCLIQUES DU VECTEUR VITESSE]

J Rebont, C Maresca, A Guillerminet, and D Favier Paris Assoc Aeron et Astronautique de France 1976 37 p refs In FRENCH Presented at the 12th Ecole Natl Super de Méc et d'Aérotech / CEAT Colloq d'Aérodyn Appl Poitiers, France 5-7 Nov 1975 (AAAF-NT-76-20 ISBN-2-7170-0398-3) Avail NTIS HC A03/MF A01 CEDOCAR Paris FF 25 (France and EEC) FF 29 (others)

Aerodynamic characteristics of a helicopter wing harmonic oscillations of which the vector is parallel to the main flow were studied in a subsonic wind tunnel. NACA profile 0012 ($l=0.495$ m $c=0.3$ m) was used. Angle of attack between -20 and 20 deg and Reynolds number between 60 000 and 400 000. It is shown that the instability effects remain small with small angle of attack and with oscillation frequencies below 0.26 ESA

N77-10023# ARO Inc., Arnold Air Force Station, Tenn
AN INTEGRAL EQUATION METHOD FOR BOUNDARY INTERFERENCE IN A PERFORATED-WALL WIND TUNNEL AT TRANSONIC SPEEDS Final Report, Jan 1974 - Oct 1975

E M Kraft AEDC Apr 1976 84 p refs (AD-A023493 ARO-PWT-TR-75-162 AEDC-TR-76-43) Avail NTIS HC A05/MF A01 CSCL 20/4

The wind tunnel boundary interference at transonic speeds on a thin airfoil in a two-dimensional perforated-wall wind tunnel was determined. The interference was found by applying an integral equation method to the nonlinear transonic small disturbance equation including embedded supersonic regions with shock waves. The kernels of the ensuing integral equation were replaced by series approximations and the integrals were evaluated in closed form. The iterative technique used to calculate the interference from the integral equation method is shown to converge rapidly and the computing time for the integral equation method is typically an order of magnitude less than present numerical methods. As a special case the integral equation method for a thin airfoil in free air was also examined. It was found that the introduction of a novel influence function yields, for the first time, a self-contained integral equation for a lifting airfoil. In addition a systematic study of the classical assumption used to simplify the integral equation shows that the integral method can provide solutions in good agreement with results from the numerical methods. GRA

N77-10024# Air Force Inst of Tech, Wright-Patterson AFB Ohio School of Engineering

AN INVESTIGATION OF THE EFFECT ON AERODYNAMIC FORCES CAUSED BY THE ADDITION OF END PLATES TO HELICOPTER ROTOR BLADES M S Thesis

Roger J Korenberg Jun 1975 76 p refs (AD-A023541 GAM/AE/74D-11) Avail NTIS HC A05/MF A01 CSCL 01/1

The purpose of this investigation was to determine the effects on lift, drag and thrust produced by a helicopter rotor after installing end plates on the blades. Fixed wing end plate theory was applied in a modified form to rotor blade calculations to investigate correlation. The results indicate that end plate factors are not satisfactory analytic tools for rotor blade calculations. End plates do increase the effective rotor radius and increase the lift at a given angle of attack and RPM, however, there are heavy penalties in power required. GRA

N77-10026# Naval Surface Weapons Center White Oak Md
NORMAL IMPINGEMENT OF A SUPERSONIC JET ON A PLANE A BASIC STUDY OF SHOCK-INTERFERENCE HEATING

Kuei-Yuan Chien 20 Dec 1975 60 p refs (AD-A024511 NSWC/WOL/TR-75-195) Avail NTIS HC A04/MF A01 CSCL 20/4

The problem of a balanced, planar or axisymmetric, supersonic jet impinging normally on a flat surface has been considered based on an inviscid theory. The object of the study was to provide a rational model for calculating shock-interference heating as produced by a type IV shock-interaction pattern. The unwanted singularity at a low supersonic Mach number peculiar to scheme I of the one-strip formulation of the method of integral relations as observed by South and by Gummer and Hunt, was successfully removed by the application of the scheme III of the one-strip formulation of the method of integral relations. The resulting simultaneous nonlinear algebraic equations were easily solved iteratively by the Newton-Raphson method. Sensitivity of the solution on various approximating functions employed was extensively investigated. Unlike the findings reported by Gummer and Hunt solutions that satisfy all well-posed boundary conditions can be obtained by the one-strip formulation. Results indicate that, for the planar case a rational engineering solution for the stagnation-point velocity gradient (and hence the peak heat-transfer rate) has been obtained. For the axisymmetric case, however solutions appear to be not quite converging. A two-strip formulation based on the method of integral relations is also included. Author (GRA)

N77-10027# McDonnell Aircraft Co St Louis Mo
PERFORMANCE OF STEADY AND INTERMITTENT BLOWING JET FLAPS AND SPANWISE UPPER SURFACE SLOTS Final Report, Apr 1973 - Nov 1975

W L Ely and F C Berrier Nov 1975 514 p refs (Contract F33615-73-C-3056 AF Proj 1476) (AD-A024364 AFFDL-TR-75-128) Avail NTIS HC A22/MF A01 CSCL 20/4

A wind tunnel test was conducted in the NASA Ames 14 foot wind tunnel to determine the performance of steady and pulsed blown jet flaps and constant percent chord spanwise upper surface slots, and to provide wing load and tail power data for a proposed Air Force COMMA (Composite Maneuver Augmentation) RPV flight test program. The tests were performed on a 72 1% scale semi-span model of the proposed vehicle with a wing leading edge sweep of 45 deg over a Mach number range of 0.4 to 1.1. The Reynolds number was approximately 4 million per foot and the angle of attack range was -5 deg to -25 deg. Full and partial span jet flaps jet flap angles of 30 deg 60 deg and 80 deg 40% and 70% constant chord slots and horizontal tail deflections of $+2$ deg 0 deg -2 deg -4 deg and -6 deg were tested over a blowing momentum coefficient range of 0 to 0.018. Balance forces wing upper and lower surface static pressures wing root bending moment wing tip accelerometer and flow

visualization data were obtained. The results in general indicated that slot blowing was ineffective, jet flaps provided lift augmentation at all angles of attack tested and drag reduction at high lift conditions and pulsed blowing provided minor benefits over steady blowing. Trimmed jet flap data indicates a Mach dependence on jet flap performance and that jet flaps provide a performance advantage only at high lifts. Author (GRA)

N77-10028# Texas Univ Austin Dept of Aerospace Engineering and Engineering Mechanics

THE DEVELOPMENT OF A COMPUTER AIDED AIRFOIL DESIGN PROCEDURE INCLUDING PRELIMINARY WIND TUNNEL EXPERIMENTS ON A LOW REYNOLDS NUMBER HIGH LIFT SECTION, VOLUME 1 Final Report, 1 Dec 1970 - 30 Nov 1975

Jimmy Charles Narramore, Ralph Dean Orlander and Ronald Oran Stearman Jan 1976 153 p refs

(Grant AF-AFOSR-1998-71 AF Proj 9782)

(AD-A024361 AFOSR-76-0536TR) Avail NTIS HC A08/MF A01 CSCL 20/4

An investigation on the state of the art of subsonic airfoil section design including a review of the historical development of airfoil design methodology was carried out. A computer aided airfoil design procedure employing current technology was developed and utilized to design a low-Reynolds number high-lift airfoil section. Preliminary wind tunnel studies were carried out on this high-lift section and the influence of flow disturbances on its performances evaluated. This study represents the first phase in determining how changes in airfoil design parameters influence the dynamical properties of the airfoil. Author (GRA)

N77-10029# Advanced Technology Center Inc Dallas, Tex **TEST VERIFICATION OF A TRANSONIC AIRFOIL DESIGN EMPLOYING ACTIVE DIFFUSION CONTROL Final Report, 13 Jun 1974 - 14 Jun 1975**

C H Haight and J G Spangler 1975 90 p refs

(Contract N62269-74-C-0517)

(AD-A024297 ATC-8-94300/5CR-34) Avail NTIS HC A05/MF A01 CSCL 20/4

Experimental results are presented that show active diffusion control, with its integrated contouring/blowing characteristics to be a viable concept for relaxing transonic airfoil design constraints. The antiseperation tailored contour (ATC) is the basic device for active diffusion control. A modified 12% thick C-141 section with a trailing edge upper surface ATC designated as the TEATC12 airfoil was selected as the proof-of-concept configuration. It incorporates the main features of active diffusion control while providing a reliable baseline for comparison. The transonic BLC/diffusion process was modeled in an axisymmetric diffuser facility. Blowing predictions for the ATC geometry were substantiated and interactions between the jet and the mainstream were examined. Experimental verification was completed by testing a TEATC12 airfoil model in the Vought Systems Division High Speed Wind Tunnel. A C-141 model was also tested to provide a direct reference for the TEATC12 results. Author

N77-10032*# Lockheed-California Co, Burbank **LH2 AIRPORT REQUIREMENTS STUDY Final Report, Sep 1975 - Feb 1976**

G D Brewer ed Oct 1976 202 p refs

(Contract NAS1-14137)

(NASA-CR-2700 LR-27581) Avail NTIS HC A10/MF A01 CSCL 21D

A preliminary assessment of the facilities and equipment which will be required at a representative airport is provided so liquid hydrogen LH2 can be used as fuel in long range transport aircraft in 1995-2000. A complete facility was conceptually designed sized to meet the projected air traffic requirement. The facility includes the liquefaction plant, LH2 storage capability, and LH2 fuel handling system. The requirements for ground

support and maintenance for the LH2 fueled aircraft were analyzed. An estimate was made of capital and operating costs which might be expected for the facility. Recommendations were made for design modifications to the reference aircraft, reflecting results of the analysis of airport fuel handling requirements, and for a program of additional technology development for air terminal related items. Author

N77-10033*# Boeing Commercial Airplane Co Seattle Wash Dept of Preliminary Design

AN EXPLORATORY STUDY TO DETERMINE THE INTEGRATED TECHNOLOGICAL AIR TRANSPORTATION SYSTEM GROUND REQUIREMENTS OF LIQUID-HYDROGEN-FUELED SUBSONIC, LONG-HAUL CIVIL AIR TRANSPORTS Final Report

Washington NASA Sep 1976 176 p refs Prepared in cooperation with United Airlines and Air Products and Chemicals Inc

(Contract NAS1-14159)

(NASA-CR-2699 D6-75775) Avail NTIS HC A09/MF A01 CSCL 01C

A baseline air terminal concept was developed which permitted airlines and the airport to operate JP- or LH2-fueled aircraft at common terminal gates. The concept included installation of a hydrogen liquefaction and storage facility on airport property as well as the fuel distribution system. The capital investment and hydrogen-related operating costs to the airlines were estimated. Author

N77-10034# Simat, Helliesen and Eichner Inc Washington, D C

AN ANALYSIS OF THE INTRASTATE AIR CARRIER REGULATORY FORUM VOLUME 1 SUMMARY REPORT

Jan 1976 49 p

(Contract DOT-OST-60078)

(AD-A023761) Avail NTIS HC A03/MF A01 CSCL 05/3

Although the regulatory environments in Texas and California differ substantially, each has resulted in the establishment of carriers which are specialized in their desire and ability to serve medium- and high-density short-haul markets. Further each has allowed these carriers to pursue a marketing and operational philosophy which has enabled them to achieve improved productivity and as a result charge lower fares. CAB regulation on the other hand has produced both tight control of entry and tight rate regulation, and has required equal fares for markets of the same distance. Consequently, there has been no development of specialized interstate carriers serving short-haul routes of density comparable to those served by the intrastate carriers. Application of a two-tier pricing system, along with improved frequency, would be expected to double the traffic volume in these markets generating more than 18 million additional air passengers each year. GRA

N77-10035# Simat Helliesen and Eichner Inc Washington, D C

AN ANALYSIS OF THE INTRASTATE AIR CARRIER REGULATORY FORUM VOLUME 2 TECHNICAL REPORT Final Report

L J Eichner N S Simat K T Carlson, and R A Sunshine Jan 1976 420 p refs

(Contract DOT-OS-60078)

(AD-A023762) Avail NTIS HC A18/MF A01 CSCL 05/3

Intrastate air carriers in California and Texas have succeeded in earning profits and providing a high level of service while keeping fares well below those charged by interstate air carriers. The three carriers analyzed in this report are not subject to regulation by the Civil Aeronautics Board (CAB) which controls both rates and routes of the trunk and local interstate air carriers. The different regulatory environments impact on the performance of the aviation system. Sixty interstate markets are identified

with potential for profitable operation at high levels of service at lower air fares and regulatory requirements to allow such service to develop can be identified Author (GRA)

N77-10036# California Univ Los Angeles Graduate School of Management

THE HELICOPTER AIR SERVICE PASSENGER PROGRAM A RETROSPECT Research Report, 1974 - 1975

Tim Yeomans and Frank G Mittelbach Sep 1975 60 p refs (PB-254830/3, CAL-URT-7(7)T-35 UMTA-CA-11-0009-75-4 Occasional-Paper-10) Avail NTIS HC A04/MF A01 CSCL 01B

The initial expectations for helicopter development and the reasons behind the helicopter's ability or inability to fulfill its predicted role in moving large numbers of people in cities and between cities and outlying areas are discussed. Attention is directed to basic helicopter characteristics and capabilities, the rationale behind the helicopter experiment, the effects of a federal subsidy granted to the industry, and an analysis of four certified helicopter carrier operations. GRA

N77-10044*# United Technologies Research Center East Hartford Conn

INVESTIGATION OF A BEARINGLESS HELICOPTER ROTOR CONCEPT HAVING A COMPOSITE PRIMARY STRUCTURE Final Report

Richard L Bielawa Marvin C Cheney, Jr and Richard C Novak Oct 1976 253 p refs (Contract NAS1-10960, DA Proj 1F1-61102-AH-45) (NASA-CR-2637, R76-911209-47) Avail NTIS HC A12/MF A01 CSCL 01C

Experimental and analytical investigations were conducted to evaluate a bearingless helicopter rotor concept (CBR) made possible through the use of the specialized nonisotropic properties of composite materials. The investigation was focused on four principal areas which were expected to answer important questions regarding the feasibility of this concept. First, an examination of material properties was made to establish moduli, ultimate strength, and fatigue characteristics of unidirectional graphite/epoxy, the composite material selected for this application. The results confirmed the high bending modulus and strengths and low shear modulus expected of this material and demonstrated fatigue properties in torsion which make this material ideally suited for the CBR application. Second, a dynamically scaled model was fabricated and tested in the low speed wind tunnel to explore the aeroelastic characteristics of the CBR and to explore various concepts relative to the method of blade pitch control. Two basic control configurations were tested: one in which pitch flap coupling could occur and another which eliminated all coupling. It was found that both systems could be operated successfully at simulated speeds of 180 knots; however, the configuration with coupling present revealed a potential for undesirable aeroelastic response. The uncoupled configuration behaved generally as a conventional hingeless rotor and was stable for all conditions tested. Author

N77-10045*# Lockheed-Georgia Co Marietta
AN ANALYTICAL STUDY FOR SUBSONIC OBLIQUE WING TRANSPORT CONCEPT

Edward S Bradley J Honrath K H Tomlin G Swift P Shumpert, and W Warnock Jul 1976 219 p refs (Contract NAS2-8686) (NASA-CR-137896 LG76ER0156) Avail NTIS HC A10/MF A01 CSCL 01C

The oblique wing concept has been investigated for subsonic transport application for a cruise Mach number of 0.95. Three different mission applications were considered and the concept analyzed against the selected mission requirements. Configuration

studies determined the best area of applicability to be a commercial passenger transport mission. The critical parameter for the oblique wing concept was found to be aspect ratio, which was limited to a value of 6.0 due to aeroelastic divergence. Comparison of the concept final configuration was made with fixed winged configurations designed to cruise at Mach 0.85 and 0.95. The crossover Mach number for the oblique wing concept was found to be Mach 0.91 for takeoff gross weight and direct operating cost. Benefits include reduced takeoff distance, installed thrust, and mission block fuel, and improved community noise characteristics. The variable geometry feature enables the final configuration to increase range by 10% at Mach 0.712 and to increase endurance by as much as 44%. Author

N77-10046*# Lockheed-Georgia Co Marietta
AN ANALYTICAL STUDY FOR SUBSONIC OBLIQUE WING TRANSPORT CONCEPT

Edward S Bradley Jul 1976 37 p refs (Contract NAS2-8686)

(NASA-CR-137897 LG76ER0156) Avail NTIS HC A03/MF A01 CSCL 01C

For abstract see N77-10045

N77-10047*# Lockheed Missiles and Space Co Sunnyvale Calif Research and Development Div
CIVIL USES OF REMOTELY PILOTED AIRCRAFT Final Report

Jon R Aderhold G Gordon and George W Scott Jul 1976 326 p refs

(Contract NAS2-8935)

(NASA-CR-137894, LMSC-D057323) Avail NTIS HC A15/MF A01 CSCL 01C

The technology effort is identified and assessed that is required to bring the civil uses of RPVs to fruition and to determine whether or not the potential market is real and economically practical. The technologies are within reach, the operational problems are manageable, and the benefits are worth the cost. To do so, the economic, technical, and environmental implications are examined. The time frame is 1980-85. Representative uses are selected, detailed functional and performance requirements are derived for RPV systems, and conceptual system designs are devised. Total system cost comparisons are made with non-RPV alternatives. The potential market demand for RPV systems is estimated. Environmental and safety requirements are examined, and legal and regulatory concerns are identified. A potential demand for 2,000-11,000 RPV systems is estimated. Typical cost savings of 25-35% compared to non-RPV alternatives are determined. There appear to be no environmental problems and the safety issue appears manageable. Author

N77-10048*# Lockheed Missiles and Space Co Sunnyvale Calif Research and Development Div
CIVIL USES OF REMOTELY PILOTED AIRCRAFT Summary Report

Jon R Aderhold G Gordon and George W Scott Jul 1976 28 p ref

(Contract NAS2-8935)

(NASA-CR-137895, LMSC-D057322) Avail NTIS HC A03/MF A01 CSCL 01C

The economic, technical, and environmental implications of remotely piloted vehicles (RPV) are examined. The time frame is 1980-85. Representative uses are selected, detailed functional and performance requirements are derived for RPV systems, and conceptual system designs are devised. Total system cost comparisons are made with non-RPV alternatives. The potential market demand for RPV systems is estimated. Environmental and safety requirements are examined, and legal and regulatory concerns are identified. A potential demand for 2,000-11,000

RVP systems is estimated Typical cost savings of 25 to 35% compared to non-RPV alternatives are determined There appear to be no environmental problems, and the safety issue appears manageable Author

**N77-10049*# Kanner (Léo) Associates Redwood City Calif
CRITICAL ANALYSIS OF COMPARISONS BETWEEN
FLIGHT TEST RESULTS AND WIND TUNNEL TEST
PREDICTIONS IN SUBSONIC AND SUPERSONIC TRANS-
PORT AIRCRAFT**

C Pelagatti, J C Pilon and J Bardaud Washington NASA
Aug 1976 56 p refs Transl into ENGLISH of French report
AGARD-CP-187, Apr 1976 Presented at the 46th Meeting of
the Flight Mech Panel Valloire, France, 9-13 Jun 1975
(Contract NASw-2790)

(NASA-TT-F-17185 AGARD-CP-187) Avail NTIS
HC A04/MF A01 CSCL 01C

In relating test results obtained from wind tunnels to results from actual flight tests corrections must be made to allow for aeroelastic effects and the effect of Reynolds' number differences Using data from Concorde and airbus tests, an attempt is made to define what degree of accuracy may be expected from aerodynamic coefficients derived from wind tunnel measurements Author

**N77-10050# Poitiers Univ (France)
BUFFETING PROBLEMS [PROBLEMES DE BUFFETING]**

J Tensi and P Perrier (Avions Marcel Dassault-Breguet Aviation)
Paris Assoc Aeron et Astronautique de France 1976 48 p
refs In FRENCH Presented at the 12th Ecole Natl Super de
Mecan et d'Aerotech/CEAT Colloq d'Aerodyn Appl Poitiers
France, 5-7 Nov 1975

(AAAF-NT-76-7, ISBN-2-7170-0385-1) Avail NTIS
HC A03/MF A01, CEDOCAR, Paris FF 25 (France and EEC)
FF 29 (others)

Wind tunnel studies of buffeting of two types of profiles in incompressible flow are presented leading edge separation NACA 65 (sub 1)012 and trailing edge separation NACA 65 (sub 3) 618 The tests were made in the wind tunnel T sub 5 P sub 0 of the return (Prandtl) and guide vane type at 40 m/s Results of the two tests are detailed and compared It is shown that with the equipment used it is possible to determine the angle of attack and Reynolds number at which flow separation occurs Also the separation progress with increasing angle of attack can be followed ESA

**N77-10051# Conservatoire National des Arts et Metiers, Paris
(France)**

**NEW BUFFETING ACQUISITION METHODS [NOUVELLES
METHODES D'ACQUISITION DE BUFFETING]**

E Gaignebet and G Heckmann (Avions Marcel Dassault-Breguet
Aviation) Assoc Aeron et Astronautique de France 1976
44 p refs In FRENCH Presented at the 12th Ecole Natl
Super de Mecan et d'Aerotech/CEAT Colloq d'Aerodyn Appl
Poitiers, France, 5-7 Nov 1975

(AAAF-NT-76-8 ISBN-2-7170-0386-X) Avail NTIS
HC A03/MF A01, CEDOCAR, Paris FF 25 (France and EEC)
FF 29 (others)

A new method for military aircraft buffeting data acquisition using wind tunnel tests is presented The data analysis principle is discussed and inertia measurements are detailed The characteristics of the aircraft model are given and the data acquisition and data processing aspects are dealt with in detail It is concluded that with the hypothesis of small displacement the use of six accelerometers is justified any two of the three accelerometers related to one direction produce comparable results ESA

N77-10052# European Space Agency Paris (France)

**THREE-COMPONENT MEASUREMENTS ON A MODEL OF
A LIGHT STOL AIRCRAFT WITH CHORDWISE BLOWING**
Horst Koerner et al May 1976 22 p refs Transl into ENGLISH
of 'Dreikomponentenmessungen am Modell eines leichten
STOL-Flugzeugs mit Ausblasen in Fluegeltiefenrichtung', DFVLR
Brunswick Report DLR-FB-75-74 7 Nov 1975 Original German
report available from DFVLR, Cologne DM 10 20

(ESA-TT-299 DLR-FB-75-74) Avail NTIS HC A02/MF A01
Investigations on a STOL aircraft with internally blown flaps
are described To avoid separation on the wing slots were
located behind the nose flap and in front of the trailing edge
flap The investigations were designed to examine maximum lift
and lift/drag ratio In addition the effectiveness of the aileron
and the horizontal tail were investigated Author (ESA)

**N77-10053# United Technologies Corp Windsor Locks, Conn
V/STOL ROTARY PROPULSION SYSTEMS NOISE
PREDICTION AND REDUCTION VOLUME 1 IDENTIFICA-
TION OF SOURCES, NOISE GENERATING MECHANISMS,
NOISE REDUCTION MECHANISMS, AND PREDICTION
METHODOLOGY Final Report**

B Magliozzi May 1976 143 p refs

(Contract DOT-FA74WA-3477)

(AD-A027389/6 FAA-RD-76-49-Vol-1) Avail NTIS
HC A07/MF A01 CSCL 01/3

The propulsion systems of current and future V/STOL vehicles can be defined as combinations of free air propellers shrouded propellers variable pitch fans fixed pitch fans tilt rotors helicopter rotors lift fans gearboxes and drive engines Noise sources for each of these propulsors gearboxes and drive engines are identified and rank ordered The noise generating mechanisms for each of the propulsor noise sources identified are defined and systematically catalogued Three approaches to reduction of propulsor noise are discussed changes in physical geometry, changes in design operating conditions and the use of acoustic treatments Computerized and graphical procedures based on methodology from the open literature are presented for predicting aerodynamic performance of and noise from the V/STOL propulsors The developed methodology allows the user to estimate the achieved noise reduction as well as the incurred performance penalties of noise reduction design features and noise attenuation devices such as partly sonic inlets and acoustic treatment Much of the noise generating mechanism substantiation data and prediction methodology are based on static operation Forward flight effects have recently been recognized as having a significant effect on the noise sources Forward flight effect corrections are included in the methodology Author

**N77-10054# United Technologies Corp Windsor Locks Conn
V/STOL ROTARY PROPULSION SYSTEMS NOISE
PREDICTION AND REDUCTION VOLUME 2 GRAPHICAL
PREDICTION METHODS Final Report**

B Magliozzi May 1976 304 p refs 3 Vol

(Contract DOT-FA74WA-3477)

(AD-A027390/4 FAA-RD-76-49-Vol-2) Avail NTIS
HC A13/MF A01 CSCL 01/3

Graphical procedures for estimating noise and performance of free air propellers variable pitch fans with inlet guide vanes variable pitch fans with outlet guide vanes, fixed pitch fans, helicopter rotors, tilt rotors and lift fans are presented Noise prediction methods for drive engines gearboxes jets with and without bypass flow as well as noise reduction and performance losses for partly sonic inlets and duct linings are also presented The procedures are extensive and applicable to a wide variety of V/STOL propulsor systems including present and future V/STOL vehicles The methods have been validated with available data wherever possible However high quality data for isolated propulsors which are free from contamination by other sources and ground reflections are somewhat limited particularly for forward flight conditions Author

N77-10055# United Technologies Corp Windsor Locks, Conn
V/STOL ROTARY PROPULSION SYSTEMS NOISE PREDICTION AND REDUCTION VOLUME 3 COMPUTER PROGRAM USERS MANUAL Final Report
 B Magliozzi May 1976 302 p refs
 (Contract DOT-FA74WA-3477)
 (AD-A027363/1, FAA-RD-76-49-Vol-3) Avail NTIS
 HC A14/MF A01 CSCL 01/3

A computer program is presented which allows a user to make performance and far field acoustic noise predictions for free air propellers, variable pitch fans with inlet guide vanes, variable pitch fans with outlet guide vanes, fixed pitch fans, helicopter rotors, tilt rotors fixed pitch lift vanes with remote integral, and tip turbine drives, and variable pitch lift fans with remote and integral drives. Noise prediction methodology for drive engines, single stream and coaxial jets and gearboxes is also included as well as noise reduction and performance losses of partly sonic inlets and duct acoustic treatment. A description of the program, detailed instructions for its use, required inputs, and sample cases are presented. Author

N77-10056# Ellico Engineering, Inc., Compton Calif
TRANSONIC PERFORMANCE OF MACH 2.65 AUXILIARY FLOW AXISYMMETRIC INLET Final Report
 Don M Santman Oct 1976 63 p refs
 (Contract NAS2-8679)
 (NASA-CR-2747) Avail NTIS HC A04/MF A01 CSCL 21E

Transonic experimental performance for a large scale Mach 2.65 axisymmetric inlet model with auxiliary airflow systems are presented. The inlet model incorporated both centerbody and cowl auxiliary airflow systems. When the centerbody system was fully open the performance at the simulated compressor face was such that at 0.10 total pressure distortion the total capture mass flow ratio increased 0.055 and 0.051 and the total pressure recovery increased 0.015 and 0.012 at Mach 0.9 and 1.3 respectively. Flow separation on the centerbody resulted in supercritical centerbody auxiliary throat flow prior to attainment of choked main duct throat flow. Cowl auxiliary airflow had a detrimental effect on compressor-face performance. To overcome the detrimental effect alternate cowl auxiliary airflow systems are described for efficient merging of auxiliary and main duct airflows and for providing similar auxiliary and main duct throat choking characteristics. Author

N77-10058# National Aeronautics and Space Administration
 Lewis Research Center, Cleveland, Ohio
EMISSIONS OF AN AVCO LYCOMING O-320-DIAD AIR COOLED LIGHT AIRCRAFT ENGINE AS A FUNCTION OF FUEL-AIR RATIO, TIMING, AND AIR TEMPERATURE AND HUMIDITY
 Phillip R Meng Michael Skorobatchky, Donald V Cosgrove and Erwin E Kempke Aug 1976 206 p refs
 (NASA-TM-X-73500) Avail NTIS HC A10/MF A01 CSCL 21G

A carbureted aircraft engine was operated over a range of test conditions to establish the exhaust levels over the EPA seven-mode emissions cycle. Baseline (full rich production limit) exhaust emissions at an induction air temperature of 59 F and near zero relative humidity were 90 percent of the EPA standard for HC, 35 percent for NO_x, and 161 percent for CO. Changes in ignition timing around the standard 25 deg BTDC from 30 deg BTDC to 20 deg BTDC had little effect on the exhaust emissions. Retarding the timing to 15 deg BTDC increased both the HC and CO emissions and decreased NO_x emissions. HC and CO emissions decreased as the carburetor was leaned out while NO_x emissions increased. The EPA emission standards were marginally achieved at two leanout conditions. Variations in the quantity of cooling air flow over the engine had no effect on exhaust emissions. Temperature-humidity effects at the higher values of air temperature and relative humidity tested indicated that the HC and CO emissions increased significantly, while the NO_x emissions decreased. Author

N77-10059# National Aeronautics and Space Administration
 Lewis Research Center, Cleveland, Ohio
SUPERSONIC VARIABLE-CYCLE ENGINES
 E A Willis and A D Welliver (Boeing Aerospace Co., Seattle, Wash) 1976 11 p refs Presented at the 12th Propulsion Conf Palo Alto, Calif., 26-29 Jul 1976, cosponsored by AIAA and SAE
 (NASA-TM-X-73524) Avail NTIS HC A02/MF A01 CSCL 21E

The evolution and current status of selected recent variable cycle engine (VCE) studies are reviewed, and how the results were influenced by airplane requirements is described. Promising VCE concepts are described, their designs are simplified and the potential benefits in terms of aircraft performance are identified. This includes range noise, emissions and the time and effort it may require to ensure technical readiness of sufficient depth to satisfy reasonable economic performance and environmental constraints. A brief overview of closely related, ongoing technology programs in acoustics and exhaust emissions is also presented. Realistic technology advancements in critical areas combined with well matched aircraft and selected VCE concepts can lead to significantly improved economic and environmental performance relative to first generation SST predictions. Author

N77-10060# Notre Dame Univ., Ind Dept of Electrical Engineering
COMPUTATIONAL ALTERNATIVES TO OBTAIN TIME OPTIMAL JET ENGINE CONTROL M.S. Thesis
 R J Basso and R J Leake Oct 1976 73 p refs
 (Grant NSG-3048)
 (NASA-CR-149106, EE-7611) Avail NTIS HC A04/MF A01 CSCL 21E

Two computational methods to determine an open loop time optimal control sequence for a simple single spool turbojet engine are described by a set of nonlinear differential equations. Both methods are modifications of widely accepted algorithms which can solve fixed time unconstrained optimal control problems with a free right end. Constrained problems to be considered have fixed right ends and free time. Dynamic programming is defined on a standard problem and it yields a successive approximation solution to the time optimal problem of interest. A feedback control law is obtained and it is then used to determine the corresponding open loop control sequence. The Fletcher-Reeves conjugate gradient method has been selected for adaptation to solve a nonlinear optimal control problem with state variable and control constraints. Author

N77-10061# Notre Dame Univ., Ind Dept of Electrical Engineering
SIMPLIFIED SIMULATION MODELS FOR CONTROL STUDIES OF TURBOJET ENGINES
 Thomas C Brennan and R Jeffrey Leake Nov 1975 93 p refs
 (Grant NSG-3048)
 (NASA-CR-149107, EE-757) Avail NTIS HC A05/MF A01 CSCL 21E

The essential dynamical characteristics of a simple single spool turbojet engine were determined through simulation of low order system models on an analog computer. An accurate model was studied and system complexity was reduced through various linearizations and approximations. A derivation of a seventh order simplified simulation model is presented with a derivation of an even simpler third order model, and simulation results from each. The control problem studied is one of getting from zero fuel flow equilibrium to a high thrust equilibrium while taking into account surge margin and turbine inlet temperature constraints. Author

N77-10062# National Aeronautics and Space Administration
 Lewis Research Center Cleveland Ohio

ADVANCED COMBUSTION TECHNIQUES FOR CONTROLLING NO SUB X EMISSIONS OF HIGH ALTITUDE CRUISE AIRCRAFT

R A Rudey and G M Reck 1976 21 p refs Presented at 27th Intern Astronaut Congr, Anaheim, Calif 10-16 Oct 1976, sponsored by AIAA (NASA-TM-X-73473 E-8858) Avail NTIS HC A02/MF A01 CSCL 21E

An array of experiments designed to explore the potential of advanced combustion techniques for controlling the emissions of aircraft into the upper atmosphere was discussed. Of particular concern are the oxides of nitrogen (NOx) emissions into the stratosphere. The experiments utilize a wide variety of approaches varying from advanced combustor concepts to fundamental flame tube experiments. Results are presented which indicate that substantial reductions in cruise NOx emissions should be achievable in future aircraft engines. A major NASA program is described which focuses the many fundamental experiments into a planned evolution and demonstration of the prevaporized-premixed combustion technique in a full-scale engine. Author

N77-10063*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio

THE IMPACT OF EMISSIONS STANDARDS ON THE DESIGN OF AIRCRAFT GAS TURBINE ENGINE COMBUSTORS

Richard A Rudey 1976 19 p refs Presented at the Aerospace Conf San Diego Calif, 29 Nov - 2 Dec 1976 sponsored by SAE (NASA-TM-X-73490) Avail NTIS HC A02/MF A01 CSCL 21E

Effective emission control techniques have been identified and a wide spectrum of potential applications for these techniques to existing and advanced engines are being considered. Results from advanced combustor concept evaluations and from fundamental experiments are presented and discussed and comparisons are made with existing EPA emission standards and recommended levels for high altitude cruise. The impact that the advanced low emission concepts may impose on future aircraft engine combustor designs and related engine components is discussed. Author

N77-10064*# Pratt and Whitney Aircraft East Hartford Conn
EXPERIMENTAL CLEAN COMBUSTOR PROGRAM NOISE STUDY

T G Sofrin and N Riloff Jr Sep 1976 191 p refs (Contract NAS3-18544) (NASA-CR-135106 PWA-5458) Avail NTIS HC A09/MF A01 CSCL 21E

Under a Noise Addendum to the NASA Experimental Clean Combustor Program (ECCP) internal pressure fluctuations were measured during tests of JT9D combustor designs conducted in a burner test rig. Measurements were correlated with burner operating parameters using an expression relating farfield noise to these parameters. For a given combustor variation of internal noise with operating parameters was reasonably well predicted by this expression but the levels were higher than farfield predictions and differed significantly among several combustors. For two burners discharge stream temperature fluctuations were obtained with fast-response thermocouples to allow calculation of indirect combustion noise which would be generated by passage of the temperature inhomogeneities through the high pressure turbine stages of a JT9D turbofan engine. Using a previously developed analysis the computed indirect combustion noise was significantly lower than total low frequency core noise observed on this and several other engines. Author

N77-10065*# National Aeronautics and Space Administration Langley Research Center Langley Station Va
ASSESSMENT OF VARIABLE-CYCLE ENGINES FOR MACH 2.7 SUPERSONIC TRANSPORTS Status Report

S J Morris W E Foss, Jr and J W Russell (Vought Corp Hampton, Va) 1 Nov 1976 59 p refs (NASA-TM-X-73977) Avail NTIS HC A04/MF A01 CSCL 21E

Three proposed SCAR propulsion systems in terms of aircraft range for a fixed payload and take-off gross weight with a design cruise Mach number 2.7 are evaluated. The effects of various noise and operational restraints are determined and sensitivities to some of the more important performance variables are presented for the most probable design noise and operational restraint case. Critical areas requiring new or improved technology for each cycle are delineated. Author

N77-10066*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio

EFFECT OF AIR TEMPERATURE AND RELATIVE HUMIDITY AT VARIOUS FUEL-AIR RATIOS ON EXHAUST EMISSIONS ON A PER-MODE BASIS OF AN AVCO LYCOMING 0-320 DIAD LIGHT AIRCRAFT ENGINE VOLUME 2 INDIVIDUAL DATA POINTS

Michael Skorobatchky Donald V Cosgrove Phillip R Meng and Edward R Kempke Sep 1976 850 p (NASA-TM-X-73507 E-8916-Vol-2) Avail NTIS HC A99/MF A01 CSCL 21E

A carbureted four cylinder air cooled 0-320 DIAD Lycoming aircraft engine was tested to establish the effects of air temperature and humidity at various fuel-air ratios on the exhaust emissions on a per-mode basis. The test conditions included carburetor lean-out at air temperatures of 50 59 80 and 100 F at relative humidities of 0 30 60 and 80 percent. Temperature-humidity effects at the higher values of air temperature and relative humidity tested indicated that the HC and CO emissions increased significantly while the NOx emissions decreased. Even at a fixed fuel-air ratio the HC emissions increase and the NOx emissions decrease at the higher values of air temperature and humidity. Volume II contains the data taken at each of the individual test points. Author

N77-10067# Technische Hochschule Aachen (West Germany) Inst fuer Luft- und Raumfahrt

NOISE GENERATING BY INTERACTION BETWEEN SUBSONIC JETS AND BLOWN FLAPS

Erch Evertz Valentin Kloeppel Guenther Neuwerth and August Wilhelm Quick Cologne DFVLR 15 Mar 1976 23 p refs Presented at AIAA Meeting, Tenn Sponsored by Min fuer Wiss u Forsch des Landes Nordrhein-Westfalen (DLR-FB-76-20) Avail NTIS HC A02/MF A01, DFVLR, Cologne DM 10 80

On the basis of experimental results the strong noise generation originating from the interference between air jets of high subsonic speed and externally blown flaps (EBF) is discussed. It is shown that in an undisturbed free jet as well as in a jet deflected by EBF there are ordered turbulence structures. An acoustical feedback mechanism which develops at small distances between nozzle and stagnation point on the flaps and which reinforces the turbulence structures is explained. It is subsequently shown that even without acoustic feedback both the undisturbed free jet and the jet deflected by EBF have their maximum noise levels at the Strouhal number of the natural ordered structures. Author (ESA)

N77-10068# Naval Air Systems Command, Washington, D C
PREDICTION METHODS FOR JET V/STOL PROPULSION AERODYNAMICS, VOLUME 1

M F Platzer Jul 1975 541 p refs Workshop held at Arlington Va 28-31 Jul 1975 (AD-A024022) Avail NTIS HC A23/MF A01 CSCL 01/1

High speed V/STOL aircraft operating from widely dispersed platforms have become of increasing interest to the U S Navy. The dispersed force concept requires a well developed technology base, involving phenomena and problems which do not occur on conventional aircraft or low speed V/STOL craft. Proper design must account for the interdependence of aerodynamic and

propulsion phenomena, and flows so complex that purely theoretical prediction is precluded at present. A two-volume report is made on a 1975 workshop to study these interactions. GRA

N77-10069# Naval Air Systems Command Washington D C
PREDICTION METHODS FOR JET V/STOL PROPULSION AERODYNAMICS, VOLUME 2

M F Platzer Jul 1975 545 p refs Workshop held at Arlington Va, 28-31 Jul 1975
 (AD-A024023) Avail NTIS HC A23/MF A01 CSCL 01/1
 For abstract see N77-10068

N77-10070# Air Force Inst of Tech, Wright-Patterson AFB Ohio School of Engineering
COMBUSTOR DESIGN FOR LOW COST EXPENDABLE TURBOJETS M S Thesis

Raymond L Greene Mar 1976 57 p refs
 (AD-A024541 GAE/AE/76M-1) Avail NTIS
 HC A04/MF A01 CSCL 21/5

The development of two experimental burners was completed as part of a project to evaluate the suitability of the use of converted reciprocating engine turbochargers as expendable jet engines for remotely piloted vehicles. As a result of analytic studies Burner A was constructed as a reverse flow burner and was designed to accept a mass flow up to 0.75 lbm/sec. Burner B was also reverse and designed for a mass flow up to 1.5 lbm/sec. Both burners operated successfully on their respective turbochargers. GRA

N77-10083# Office National d Etudes et de Recherches Aeronautiques Paris (France)
INFLUENCE OF WIND TUNNEL WALL BOUNDARY LAYERS ON TWO DIMENSIONAL TRANSONIC TESTS

Rene Bernard-Guelle Assoc Aeron et Astronautique de France 1976 24 p refs In FRENCH ENGLISH summary Presented at the 12th Ecole Natl Super de Mecan et d Aerotech /CEAT Colloq Appl Poitiers France 5-7 Nov 1975
 (AAAF-NT-76-13 ISBN-2-7170-0391-6) Avail NTIS
 HC A02/MF A01, CEDOCAR, Paris FF 15 (France and EEC) FF 19 (others)

Wind tunnel tests on the aspiration of the boundary layer upstream of the reference profiles NACA 0012 and LC 100D are discussed. The two-dimensional test section of the ONERA R1Ch wind tunnel contains a porous wall permitting partial aspiration of the boundary layer upstream of the model. The aspiration rate is adjustable and generates a variation of the displacement thickness from 5 to 1% of the model half-span permitting in some cases the extrapolation of the results to the extreme case of no boundary layer. The effect of wall boundary layers appears as a variation of the profile performance and a displacement of the shock waves. To compare the results obtained in various wind tunnels this parameter should be taken into consideration. It appears very difficult to establish a method for correcting these wall boundary layer effects therefore it seems mandatory to reduce them as far as possible. Author (ESA)

N77-10090# Texas Univ Austin Dept of Aerospace Engineering and Engineering Mechanics

THE DESIGN, ANALYSIS AND TESTING OF A LOW BUDGET WIND TUNNEL FLUTTER MODEL WITH ACTIVE AERODYNAMIC CONTROLS, VOLUME 2 Final Report, 1 Dec 1970 - 30 Nov 1975

Randall M Bolding and Ronald O Stearman Jan 1976 34 p refs Presented at the NASA Symp on Flutter Testing, Edwards, Calif 9-10 Oct 1975
 (Grant AF-AFOSR-1998-71, AF Proj 9782)
 (AD-A024480 AFOSR-76-0537TR-Vol-2) Avail NTIS
 HC A03/MF A01 CSCL 20/4

This report describes a low budget flutter model incorporating active aerodynamic controls for flutter suppression studies, concentrating on the interfering lifting surface flutter phenomenon

in the form of a swept wing-tail configuration. A flutter suppression mechanism was first demonstrated on a simple semi-rigid three degree of freedom flutter model of this configuration employing an active stabilator control. These preliminary studies were extended to the analysis of a larger degree of freedom AFFDL wing-tail flutter model. The analytical and experimental design of a flutter suppression system for the AFFDL model is presented along with the results of a preliminary passive flutter test. Author (GRA)

N77-10162# European Space Agency, Paris (France)
THEORETICAL AND EXPERIMENTAL INVESTIGATIONS ON LANDING GEAR SPRING BLADES OUT OF FIBER REINFORCED PLASTIC FOR SMALL AIRCRAFT

Rainer Schuetze Sep 1976 35 p refs Transl into ENGLISH of Theoretische u exptl Untersuchung an Fahrwerksfederblaettern aus faserverstaerkten Kunststoffen fuer Kleinflugzeuge DFVLR, Brunswick Report DLR-FB-76-06, 12 Jan 1976 Original German report available from DFVLR, Cologne DM 16 20
 (ESA-TT-312 DLR-FB-76-06) Avail NTIS HC A03/MF A01

The development of several landing gear spring blades for a small aircraft is described. A special sandwich structure not only minimized the weight of the spring blade but also enabled it to resist both high longitudinal stresses in the facing layers and high shear stresses in the core. The considerable length of these spring blades made it essential for them to have a high flexural rigidity. Carbon and Kevlar 49 fibers both of which have a greater modulus of elasticity than glass fibers were therefore used as alternative reinforcements in the facing layers on the tension side of the blades. All the blades were subjected to dynamic and static testing with the help of a gravitational-fall test bed. The use of Kevlar 49 fibers in the tension flange of the sandwich permitted the weight to be reduced even as compared with the GRP sandwich and an improved damping behavior was also obtained. Author (ESA)

N77-10183*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio

HOT CORROSION STUDIES OF FOUR NICKEL-BASE SUPERALLOYS B-1900, NASA-TRW VIA, 713C AND IN738

George C Fryburg Fred J Kohl, and Carl A Stearns 1976 11 p refs Presented at Symp on Properties of High Temp Alloys Las Vegas Nev 17-22 Oct 1976 sponsored by the Electrochem Soc and the Met Soc of the Am Inst of Mining Met and Petrol Engrs
 (NASA-TM-X-73479) Avail NTIS HC A02/MF A01 CSCL 11F

The susceptibility to hot corrosion of four nickel base superalloys has been studied at 900 deg and 1000 deg C in one atmosphere of slowly flowing oxygen. Hot corrosion was induced by coating the samples with known doses of NaSO₄ and oxidizing the coated samples isothermally on a sensitive microbalance. In general the order of susceptibility found was B-1900 is greater than 713C is greater than NASA-TRW VIA and is greater than IN738. This order corresponds to the order of decreasing molybdenum content of the alloys. Chemical evidence for B-1900 indicates that hot corrosion is instigated by acid fluxing of the protective Al₂O₃ coating by MoO₃.

Author

N77-10195# Aluminum Co of America Alcoa Center, Pa Alcoa Labs

DESIGN MECHANICAL PROPERTIES, FRACTURE TOUGHNESS, FATIGUE PROPERTIES, EXFOLIATION AND STRESS-CORROSION RESISTANCE OF 7050 SHEET, PLATE, HAND FORGINGS, DIE FORGINGS AND EXTRUSIONS Final Report, 12 May 1972 - 12 Nov 1974

R E Davies G E Nordmack and J D Walsh Jul 1975 301 p refs
 (Contract N00019-72-C-0512)
 (AD-A024609) Avail NTIS HC A14/MF A01 CSCL 11/6

The mechanical properties including fracture toughness and fatigue crack growth rates and corrosion characteristics

have been determined for a total of 51 lots of 7050-T76 sheet, 7050-T73651 plate 7050-T73652 hand forgings, 7050-T736 die forgings and 7050-T76511 extruded shapes. Tables of computed design mechanical properties, modulus of elasticity values and individual stress-strain curves are presented. The critical stress-intensity factor, (K_{Ic}), was determined for samples of each lot of sheet and the plane-strain stress-intensity factor, (K_{Ic}) was determined for plate hand and die forgings and extruded shapes. The combination of strength and toughness of all products are generally comparable to or higher than those of conventional 7XXX alloys. Axial-stress fatigue strengths were determined in ambient-air and salt-fog environments. Modified Goodman diagrams were developed from tests made in ambient air. GRA

N77-10210# Lockheed Aircraft Corp., Marietta Ga
FULL TEMPERATURE RANGE PROTECTIVE SYSTEM FOR FASTENER AREAS OF CARRIER-BASED NAVAL AIRCRAFT
 Summary Report, 1 Jan 1974 - 31 Dec 1975
 R N Miller G G Seeliger, and W A Boggs Feb 1976
 107 p refs
 (Contract N00019-74-C-0267)
 (AD-A024523, LG76ER0029) Avail NTIS HC A06/MF A01
 CSCL 11/3

Results are presented for a program to develop a full temperature range (-65 to 325 F) protective systems for carrier-based aircraft. Selected primers, intermediate coatings and topcoats were subjected to screening tests. The best coating systems were applied to aluminum and titanium specimens representative of aircraft joints. After five cycles of a simulated flight spectrum the specimens were checked for coating defects, corrosion, and coating adhesion. The most effective coating combinations were three-layer systems composed of a MIL-P-23377 epoxy-polyamide primer, an aliphatic linear polyurethane topcoat and intermediate coats of elastomeric polyurethane or inhibited polysulfide. These plus an additional system with an inhibited polysulfide primer and polyurethane topcoat were applied to A-7 carrier-based Navy aircraft during 1975. Plans were made for the periodic inspection of the test aircraft over a span of 3 years. Navy C-130 Aircraft BUNO 149787 with experimental coating systems on the upper center wing was given a two-year inspection in August 1975. Except for minor scratches, all systems were in excellent condition. Author (GRA)

N77-10230*# National Aeronautics and Space Administration
 Langley Research Center Langley Station Va
ADVANCES IN ENGINEERING SCIENCE, VOLUME 1
 1976 360 p refs Presented at the 13th Ann Meeting of
 The Soc of Eng Sci 1-3 Nov 1976, Hampton, Va, sponsored
 by JIAFS and George Washington Univ 1 Vol
 (NASA-CP-2001-Vol-1) Avail NTIS HC A16/MF A01 CSCL
 13M

Proceedings from a conference on engineering advances are presented including materials science fracture mechanics, and impact and vibration testing. The tensile strength and moisture transport of laminates are also discussed.

N77-10311*# National Aeronautics and Space Administration
 Lewis Research Center Cleveland, Ohio
INLET NOISE SUPPRESSOR DESIGN METHOD BASED UPON THE DISTRIBUTION OF ACOUSTIC POWER WITH MODE CUTOFF RATIO
 Edward J Rice *In its Advan in Eng Sci* Vol 3 1976 p 883-894
 refs
 Avail NTIS HC A20/MF A01 CSCL 20A

A liner design for noise suppressors with outer wall treatment such as in an engine inlet is presented which potentially circumvents the problems of resolution in modal measurement. The method is based on the fact that the modal optimum impedance and the maximum possible sound power attenuation at this optimum can be expressed as functions of cutoff ratio alone. Modes with similar cutoff ratios propagate similarly in

the duct and in addition propagate similarly to the far field. Thus there is no need to determine the acoustic power carried by these modes individually and they can be grouped together as one entity. With the optimum impedance and maximum attenuation specified as functions of cutoff ratio, the off-optimum liner performance can be estimated using an approximate attenuation equation. Author

N77-10344*# National Aeronautics and Space Administration
 Langley Research Center, Langley Station, Va
HYDROGEN-FUELED SUBSONIC AIRCRAFT A PERSPECTIVE
 Robert D Witcofski *In its Advan in Eng Sci*, Vol 3 1976
 p 1265-1278 refs
 Avail NTIS HC A20/MF A01 CSCL 21D

The performance characteristics of hydrogen-fueled subsonic transport aircraft are compared to those using conventional aviation kerosene. Additional aspects discussed include potential improvements in the exhaust emissions characteristics of aircraft jet engines, problems associated with onboard fuel containment, results of recent studies of the impact of hydrogen-fueled aircraft on the airport and associated ground support equipment, and estimates of the cost and thermal efficiency of producing synthetic aviation fuels from coal. Author

N77-10345*# National Aeronautics and Space Administration
 Langley Research Center, Langley Station Va
ADVANCES IN ENGINEERING SCIENCE, VOLUME 4
 1976 521 p refs Presented at 13th Ann Meeting of Soc of
 Eng Sci, Hampton, Va 1-3 Nov 1976 sponsored by JIAFS
 and George Washington Univ 4 Vol
 (NASA-CP-2001-Vol-4) Avail NTIS HC A22/MF A01 CSCL
 13M

The following areas of flight science are discussed in detail, (1) inviscid flow (2) viscous flow (3) aircraft aerodynamics, (4) fluid mechanics (5) propulsion and combustion and (6) flight dynamics and control.

N77-10347*# North Carolina State Univ Raleigh Dept of
 Mechanical and Aerospace Engineering
LIFTING SURFACE THEORY FOR RECTANGULAR WINGS

Fred R DeJarnette *In NASA Langley Res Center Advan in Eng Sci* Vol 4 1976 p 1301-1309 refs

(Grant DAAG29-76-G-0045)
 Avail NTIS HC A22/MF A01

A new incompressible lifting-surface theory is developed for thin rectangular wings. The solution requires the downwash equation to be in the form of Cauchy-type integrals. Lan's method is employed for the chordwise integrals since it properly accounts for the leading-edge singularity, Cauchy singularity and Kutta condition. The Cauchy singularity in the spanwise integral is also accounted for by using the midpoint trapezoidal rule and theory of Chebyshev polynomials. The resulting matrix equation formed by satisfying the boundary condition at control points, is simpler and quicker to compute than other lifting surface theories. Solutions were found to converge with only a small number of control points and to compare favorably with results from other methods. Author

N77-10348*# National Aeronautics and Space Administration
 Ames Research Center Moffett Field, Calif
 consumption by reducing drag. Computer codes have served well in meeting the consequent demand for new wing sections. The possibility of replacing wind tunnel tests by computational fluid dynamics is discussed. Another approach to the supercritical wing is through shockless airfoils. A novel boundary value problem in

the hodograph plane is studied that enables one to design a shockless airfoil so that its pressure distribution very nearly takes on data that are prescribed Author

N77-10349*# Virginia Polytechnic Inst and State Univ Blacksburg
APPLICATION OF THE NONLINEAR VORTEX-LATTICE CONCEPT TO AIRCRAFT-INTERFERENCE PROBLEMS

Osama A Kandil Dean T Mook and Ali H Nayfeh In NASA Langley Res Center Advan in Eng Sci, Vol 4 1976 p 1321-1330 refs

Avail NTIS HC A22/MF A01

A discrete-vortex model was developed to account for the hazardous effects of the vortex trail issued from the edges of separation of a large leading wing on a small trailing wing. The model is divided into three main parts: the leading wing and its near wake, the near and far wakes of the leading wing, and the trailing wing and the portion of the far wake in its vicinity. The normal force, pitching moment and rolling moment coefficients for the trailing wing are calculated. The circulation distribution in the vortex trail is calculated in the first part of the model where the leading wing is far upstream and hence is considered isolated. A numerical example is solved to demonstrate the feasibility of using this method to study interference between aircraft. The numerical results show the correct trends. The following wing experiences a loss in lift between the wing-tip vortex systems of the leading wing, a gain outside this region, and strong rolling moments which can change sign as the lateral relative position changes. All the results are strongly dependent on the vertical relative position. Author

N77-10350*# National Aeronautics and Space Administration Langley Research Center Langley Station Va
AN APPLICATION OF THE SUCTION ANALOG FOR THE ANALYSIS OF ASYMMETRIC FLOW SITUATIONS

James M Luckring In its Advan in Eng Sci Vol 4 1976 p 1331-1347 refs

Avail NTIS HC A22/MF A01 CSCL 01A

A recent extension of the suction analogy for estimation of vortex loads on asymmetric configurations is reviewed. This extension includes asymmetric augmented vortex lift and the forward sweep effect on side edge suction. Application of this extension to a series of skewed wings has resulted in an improved estimating capability for a wide range of asymmetric flow situations. Hence the suction analogy concept now has more general applicability for subsonic lifting surface analysis. Author

N77-10351*# New York Univ, N.Y. Courant Inst of Mathematical Sciences
TRANSONIC FLOW THEORY OF AIRFOILS AND WINGS

P R Garabedian In NASA Langley Res Center Advan in Eng Sci Vol 4 1976 p 1349-1358 refs

(Grants NGR-33-016-167 NGR-33-016-201 Contract AT(11-1)-3077)

Avail NTIS HC A22/MF A01

There are plans to use the supercritical wing on the next generation of commercial aircraft so as to economize on fuel consumption by reducing drag. Computer codes have served well in meeting the consequent demand for new wing sections. The possibility of replacing wind tunnel tests by computational fluid dynamics is discussed. Another approach to the supercritical wing is through shockless airfoils. A novel boundary value problem in the hodograph plane is studied that enables one to design a shockless airfoil so that its pressure distribution very nearly takes on data that are prescribed. Author

N77-10354*# Texas A&M Univ, College Station
INVERSE TRANSONIC AIRFOIL DESIGN INCLUDING VISCOUS INTERACTION

Leland A Carlson In NASA Langley Res Center Advan in Eng Sci Vol 4 1976 p 1387-1395 refs

(Grant NsG-1174)

Avail NTIS HC A22/MF A01

A numerical technique was developed for the analysis of specified transonic airfoils or for the design of airfoils having a prescribed pressure distribution, including the effect of weak viscous interaction. The method uses the full potential equation, a stretched Cartesian coordinate system, and the Nash-MacDonald turbulent boundary layer method. Comparisons with experimental data for typical transonic airfoils show excellent agreement. An example shows the application of the method to design a thick aft-cambered airfoil and the effects of viscous interaction on its performance are discussed. Author

N77-10355*# Mississippi State Univ, Mississippi State
NUMERICAL SOLUTIONS FOR LAMINAR AND TURBULENT VISCOUS FLOW OVER SINGLE AND MULTI-ELEMENT AIRFOILS USING BODY-FITTED COORDINATE SYSTEMS

Joe F Thompson Z U A Warsi, and B B Amlicke In NASA Langley Res Center Advan in Eng Sci Vol 4 1976 p 1397-1407 refs

(Grants NGR-25-001-005 AF-AFOSR-2922-76)

Avail NTIS HC A22/MF A01

The technique of body-fitted coordinate systems is applied in numerical solutions of the complete time-dependent compressible and incompressible Navier-Stokes equations for laminar flow and to the time-dependent mean turbulent equations closed by modified Kolmogorov hypotheses for turbulent flow. Coordinate lines are automatically concentrated near to the bodies at higher Reynolds number so that accurate resolution of the large gradients near the solid boundaries is achieved. Two-dimensional bodies of arbitrary shapes are treated, the body contour(s) being simply input to the program. The complication of the body shape is thus removed from the problem. Author

N77-10365*# National Aeronautics and Space Administration Langley Research Center, Langley Station Va
ADVANCED TRANSONIC AERODYNAMIC TECHNOLOGY

Richard T Whitcomb In its Advan in Eng Sci Vol 4 1976 p 1521-1537 refs

Avail NTIS HC A22/MF A01 CSCL 01A

Supercritical airfoils and their applications to wings for various types of aircraft are studied. The various wings discussed were designed for a subsonic jet transport with increased speed, a variable sweep fighter with greater transonic maneuverability, a high subsonic speed STOL jet transport with improved low speed characteristics, and a subsonic jet transport with substantially improved aerodynamic efficiency. Results of wind tunnel and flight demonstration investigations are described. Also discussed are refinements of the transonic area rule concept and methods for reducing the aerodynamic interference between engine nacelles and wings at high subsonic speeds. Author

N77-10366*# Lockheed-Georgia Co, Marietta
DESIGN CONSIDERATIONS FOR LAMINAR FLOW CONTROL AIRCRAFT

R F Sturgeon and J A Bennett In NASA Langley Res Center Advan in Eng Sci Vol 4 1976 p 1539-1548 refs

(Contract NAS1-13694)

Avail NTIS HC A22/MF A01

A study was conducted to investigate major design considerations involved in the application of laminar flow control to the

wings and empennage of long range subsonic transport aircraft compatible with initial operation in 1985. For commercial transports with a design mission range of 10,186 km (5500 n mi) and a payload of 200 passengers, parametric configuration analyses were conducted to evaluate the effect of aircraft performance, operational and geometric parameters on fuel efficiency. Study results indicate that major design goals for aircraft optimization include maximization of aspect ratio and wing loading and minimization of wing sweep consistent with wing volume and airport performance requirements. Author

N77-10367* Pennsylvania State Univ., University Park. Dept of Aerospace Engineering

ON THE STATUS OF V/STOL FLIGHT

Barnes W. McCormick. In NASA Langley Res. Center. Advan in Eng. Sci., Vol. 4, 1976, p. 1549-1562, refs.

Avail. NTIS HC A22/MF A01

Basic principles relating to the accomplishment of V/STOL flight are reviewed as they pertain to current prototype developments. Particular consideration is given to the jet flap flow augmentation and circulation control separately and in combination. Configurations as the augmentor wing upper-surface blown flaps, externally blown flaps and the circulation-controlled rotor are also examined. Author

N77-10368* National Aeronautics and Space Administration. Langley Research Center. Langley Station, Va.

THE CRYOGENIC WIND TUNNEL

Robert A. Kilgore. In its Advan in Eng. Sci., Vol. 4, 1976, p. 1565-1581, refs.

Avail. NTIS HC A22/MF A01 CSCL 14B

Based on theoretical studies and experience with a low speed cryogenic tunnel and with a 1/3-meter transonic cryogenic tunnel, the cryogenic wind tunnel concept was shown to offer many advantages with respect to the attainment of full scale Reynolds number at reasonable levels of dynamic pressure in a ground based facility. The unique modes of operation available in a pressurized cryogenic tunnel make possible for the first time the separation of Mach number, Reynolds number and aeroelastic effects. By reducing the drive-power requirements to a level where a conventional fan drive system may be used, the cryogenic concept makes possible a tunnel with high productivity and run times sufficiently long to allow for all types of tests at reduced capital costs and, for equal amounts of testing, reduced total energy consumption in comparison with other tunnel concepts. Author

N77-10377* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

DESIGN OF ACTIVE CONTROLS FOR THE NASA F-8 DIGITAL FLY-BY-WIRE AIRPLANE

Joseph Gera. In its Advan in Eng. Sci., Vol. 4, 1976, p. 1687-1701, refs.

Avail. NTIS HC A22/MF A01 CSCL 01C

The design of a set of control laws for the NASA F-8 digital fly by wire research airplane is described. These control laws implement several active controls functions: maneuver load control, ride smoothing and departure boundary limiting. The criteria and methods which were used in the design of the control laws are also included. Results of linear analyses and nonlinear simulation are summarized. Author

N77-10378* Aerospace Systems, Inc., Burlington, Mass.

PERFORMANCE ANALYSIS OF FLEXIBLE AIRCRAFT WITH ACTIVE CONTROL

Richard B. Noll and Luigi Morino (Boston Univ.). In NASA Langley Res. Center. Advan in Eng. Sci., Vol. 4, 1976,

p. 1703-1711, refs.

(Contract NAS1-13371)

Avail. NTIS HC A22/MF A01

Small perturbation equations of motion of a flexible aircraft with an active control technology (ACT) system were developed to evaluate the stability and performance of the controlled aircraft. The total aircraft system was formulated in state vector format and the system of equations was completed with fully unsteady and low frequency aerodynamics for arbitrary, complex configurations based on a potential aerodynamic method. The ACT system equations were incorporated in the digital computer program FCAP (Flight Control Analysis Program) which can be used for the analysis of complete aircraft configurations, including control system with either low frequency or fully unsteady aerodynamics. The application of classical performance analyses including frequency response, poles and zeros, mean square response, and time response in FCAP in state vector format was discussed. Author

N77-10379* North Carolina State Univ., Raleigh. Dept of Mechanical and Aerospace Engineering

BEST-RANGE FLIGHT CONDITIONS FOR CRUISE-CLIMB FLIGHT OF A JET AIRCRAFT

Francis J. Hale. In NASA Langley Res. Center. Advan in Eng. Sci., Vol. 4, 1976, p. 1713-1719, refs.

Avail. NTIS HC A22/MF A01

The Breguet range equation was developed for cruise climb flight of a jet aircraft to include the climb angle and is then maximized with respect to the no wind true airspeed. The expression for the best range airspeed is a function of the specific fuel consumption and minimum drag airspeed and indicates that an operational airspeed equal to the fourth root of three times the minimum-drag airspeed introduces range penalties of the order of one percent. Author

N77-10381* National Aeronautics and Space Administration. Langley Research Center. Langley Station, Va.

RESULTS OF RECENT NASA STUDIES ON AUTOMATIC SPIN PREVENTION FOR FIGHTER AIRCRAFT

Joseph R. Chambers and Luat T. Nguyen. In its Advan in Eng. Sci., Vol. 4, 1976, p. 1733-1751, refs.

Avail. NTIS HC A22/MF A01 CSCL 01C

A broad based research program was developed to eliminate or minimize inadvertent spins for advanced military aircraft. Recent piloted simulator studies and airplane flight tests have demonstrated that the automatic control systems in use on current fighters can be tailored to provide a high degree of spin resistance for some configurations without restrictions to maneuverability. Such systems result in greatly increased tactical effectiveness, safety, and pilot confidence. Author

N77-10383* Youngstown State Univ., Ohio.

TERMINAL AREA GUIDANCE ALONG CURVED PATHS. A STOCHASTIC CONTROL APPROACH

J. E. Quaranta and R. H. Foulkes, Jr. In NASA Langley Res. Center. Advan in Eng. Sci., Vol. 4, 1976, p. 1767-1777, refs.

(Grant NSG-1199)

Avail. NTIS HC A22/MF A01

Stochastic control theory is applied to the problem of designing a digital flight compensator for terminal guidance along a helical flight path as a prelude to landing. The development of aircraft, wind, and measurement models is discussed along with a control scheme consisting of feedback gains multiplying estimate of the aircraft and wind states obtained from a Kalman one step predictor. Preliminary results are presented which indicate that the compensator performs satisfactorily in the presence of both steady winds and gusts. Author

N77-10432*# Massachusetts Inst of Tech Cambridge
Electronic Systems Lab

**LINEAR REGULATOR DESIGN FOR STOCHASTIC SYSTEMS
BY A MULTIPLE TIME SCALES METHOD**

Demosthenis Teneketzis and Nils R Sandell Jr [1976] 19 p
refs

(Grants NGL-22-009-124, E(49-18)-2087)

(NASA-CR-149099) Avail NTIS HC A02/MF A01 CSCL
09A

A hierarchically-structured suboptimal controller for a linear stochastic system composed of fast and slow subsystems is considered. The controller is optimal in the limit as the separation of time scales of the subsystems becomes infinite. The methodology is illustrated by design of a controller to suppress the phugoid and short period modes of the longitudinal dynamics of the F-8 aircraft

Author

N77-10512# Aeronautical Systems Div Wright-Patterson AFB
Ohio PRAM Program Office

LCC ANALYSIS OF FLIGHT RECORDER FOR F-4 WILD

WEASEL AIRCRAFT Final Report

Thomas D Meitzler 7 Apr 1976 7 p refs

(AD-A023830 ASD, RAXA-76-6) Avail NTIS
HC A02/MF A01 CSCL 14/3

This report briefly summarizes a basic life cycle cost effort on two flight recorders. It discusses the background approach results and conclusions of the study

GRA

N77-10556*# United Technologies Research Center, East
Hartford Conn

**AEROELASTIC ANALYSIS FOR HELICOPTER ROTOR
BLADES WITH TIME-VARIABLE, NON-LINEAR STRUC-
TURAL TWIST AND MULTIPLE STRUCTURAL RE-
DUNDANCY MATHEMATICAL DERIVATION AND
PROGRAM USER'S MANUAL Final Report**

Richard L Bielawa Oct 1976 155 p refs

(Contract NAS1-10960 DA Proj 1F1-61102-AH-45)

(NASA-CR-2638) Avail NTIS HC A08/MF A01 CSCL 01C

The differential equations of motion for the lateral and torsional deformations of a nonlinearly twisted rotor blade in steady flight conditions together with those additional aeroelastic features germane to composite bearingless rotors are derived. The differential equations are formulated in terms of uncoupled (zero pitch and twist) vibratory modes with exact coupling effects due to finite time variable blade pitch and to second order twist. Also presented are derivations of the fully coupled inertia and aerodynamic load distributions automatic pitch change coupling effects structural redundancy characteristics of the composite bearingless rotor flexbeam - torque tube system in bending and torsion, and a description of the linearized equations appropriate for eigensolution analyses. Three appendixes are included presenting material appropriate to the digital computer program implementation of the analysis, program G400

Author

N77-10640*# National Aeronautics and Space Administration
Lewis Research Center Cleveland Ohio

**EARLY OPERATION EXPERIENCE ON THE ERDA/NASA
100 kW WIND TURBINE**

John C Glasgow and Bradford S Linscott Sep 1976 25 p
refs

(NASA-TM-X-71601 E-8076) Avail NTIS HC A02/MF A01
CSCL 10A

As part of the Energy Research and Development Administration (ERDA) wind energy program, NASA Lewis Research Center is testing an experimental 100-kW wind turbine. Rotor blade and drive shaft loads and tower deflection were measured during operation of the wind turbine at rated rpm. The blade loads measured are higher than anticipated. Preliminary results indicate that air flow blockage by the tower structure probably caused the high rotor blade bending moments

Author

N77-10690# Urban Systems Research and Engineering Inc
Cambridge Mass

**BASELINE ENERGY FORECASTS AND ANALYSIS OF
ALTERNATIVE STRATEGIES FOR AIRLINE FUEL CONSER-
VATION**

Jul 1976 199 p

(Contract FEA-C-04-50088-00)

(PB-255351/9 FEA/D-76/026 FEA/D-CP-48) Avail NTIS
HC A09/MF A01 CSCL 10A

Baseline forecasts of airline activity and energy consumption to 1990 were developed to evaluate the impact of fuel conservation strategies. Alternative policy options to reduce fuel consumption were identified and analyzed for three baseline levels of aviation activity within the framework of an aviation activity/energy consumption model. By combining the identified policy options a strategy was developed to provide incentives for airline fuel conservation. Strategies and policy options were evaluated in terms of their impact on airline fuel conservation and the functioning of the airline industry as well as the associated social environmental and economic costs

GRA

N77-10873# European Space Agency, Paris (France)

**EXPERIMENTS ON THE FEASIBILITY OF AERO-Acoustic
MEASUREMENTS IN THE 3-m LOW SPEED WIND TUNNEL
OF THE DFVLR-AVA**

Friedrich-Reinhard Grosche et al Sep 1976 36 p refs Transl into ENGLISH of 'Expt zur Moeglichkeit von aeroakustischen Messungen im 3-m-Niedergeschwindigkeitswindkanal der DFVLR-AVA' DFVLR Goettingen West Ger Report DLR-FB-75-52 26 Nov 1975. Original German report available from DFVLR, Cologne DM 19,90

(ESA-TT-311 DLR-FB-75-52) Avail NTIS HC A03/MF A01

The experiments include measurements of the tunnel noise and measurements of the noise of a high subsonic jet emanating from a nozzle of 5 cm diameter located in a test section of the wind tunnel. The noise level of the jet was 10 to 20 db higher at frequencies about 2 kHz than the noise level of the tunnel although a large airplane model producing additional flow noise was installed in the test section

Author (ESA)

N77-10997*# Transemanatics Inc Washington D C

**VISCOUS INTERACTION WITH SEPARATION IN TRAN-
SONIC FLOW**

J Delery J J Chattot and J C LeBalleur NASA Aug 1976 27 p refs Transl into ENGLISH of ONERA conf paper Presented at Flow Separation, AGARD Fluid Dyn Symp Goettingen West Germany 27-30 May 1975

(Contract NASw-2792)

(NASA-TT-F-17187) Avail NTIS HC A03/MF A01 CSCL
01A

Strong viscous interactions which are present in transonic flows past airfoils give rise to an important thickening of the boundary layer with the frequent formation of a separated region. Under such conditions, the calculation of the flow must call upon rapid interaction theories whose application for the case of a turbulent boundary layer is examined in conjunction with experimental analysis. The experiments were conducted in a continuous wind tunnel equipped with a two dimensional nozzle having a 120 sq cm section. The experimental installation is made of a half profile mounted on the lower wall of the transonic channel. A detailed analysis of the flow field was made by using interferometry a measuring technique which avoids any disturbance of the flow. At the same time an effort was made to develop a method of calculation similar to Klineborg's approach

Author

N77-10998*# National Aeronautics and Space Administration
Langley Research Center Langley Station Va

**EFFECTS OF JETS, WAKES, AND VORTICES ON LIFTING
SURFACES**

Richard J Margason Nov 1976 15 p refs Presented at the AGARD Flight Dyn Panel Round Table Discussion Meeting

Moffett Field, Calif. 30 Sep - 1 Oct 1976
(NASA-TM-X-73974) Avail NTIS HC A02/MF A01 CSCL 01A

The interaction of jets, wakes, and vortices on lifting bodies represents a broad spectrum of aerodynamic flow phenomena. A literature survey is presented of 79 research activities in related aerodynamic situations. Author

N77-10999# National Aeronautical Establishment, Ottawa (Ontario)

CONTROLLED AND UNCONTROLLED FLOW SEPARATION IN THREE DIMENSIONS

D J Peake Jul 1976 70 p refs Presented at Symp on Viscous Flows Marietta Ga, 22-23 Jun 1976 (LR-591, NRC-15471 ISSN-0077-5541) Avail NTIS HC A04/MF A01

The advantages of swept, sharp edges that generate controlled (or fixed) three dimensional flow separations on a vehicle - because of the qualitatively unchanging flowfield developed throughout the range of flight conditions are promoted in preference to allowing uncontrolled (or unfixed) separations. The three dimensional viscous flowfields and vortical interactions about typical components such as delta wings and bodies at incidence are discussed in apposition to their use on selected examples of current flight vehicles. Author

N77-11001*# National Aeronautics and Space Administration Langley Research Center Langley Station Va

A FLIGHT INVESTIGATION OF PILOTING TECHNIQUES AND CROSSWIND LIMITATIONS DURING VISUAL STOL-TYPE LANDING OPERATIONS

Bruce D Fisher, Robert A Champine Perry L Deal James M Patton Jr and Albert W Hall Washington Oct 1976 57 p refs (NASA-TN-D-8284 L-10923) Avail NTIS HC A04/MF A01 CSCL 05H

A flight research program was undertaken to investigate problems concerned with landing a STOL airplane in crosswind conditions. The program included a study of piloting techniques and crosswind limitations during visual STOL type landing operations. The results indicated that the crosswind was more limiting during the ground roll out than during the airborne phases. The pilots estimated that the crosswind limit for commercial STOL type operations with the test aircraft would be approximately 15 to 20 knots. The pilots thought that the crosswind limits for ground operation might be extended by incorporating wing-lift spoilers improved nose gear steering, and improved engine response. The pilots agreed that a crosswind landing gear would also be beneficial. Author

N77-11002# Lockheed Missiles and Space Co Huntsville Ala
DEVELOPMENT OF PREDICTIVE WAKE VORTEX TRANSPORT MODEL FOR TERMINAL AREA WAKE VORTEX AVOIDANCE Final Report, Feb - Oct 1975

M R Brashears A D Zalay L C Chou and K R Shrider May 1976 232 p refs (Contract DOT-TSC-988) (AD-A029049/4 LMSC-HREC-TR-D496597 FAA-RD-76-94 DOT-TSC-FAA-76-15) Avail NTIS HC A11/MF A01 CSCL 01/2

The wake vortex transport program was expanded to include viscous effects and the influence of initial roll-up atmospheric turbulence and wind shear on the persistence and motion of wake vortices in terminal areas. Analysis of wake characteristics show that changes in the spanwise loading due to flaps increase the initial sink rate decrease the separation and initiates the circulation decay process earlier. Buoyancy due to jet exhaust entrainment and ambient stratification retards vortex spreading and increases descent. Atmospheric turbulence and shear promote a more rapid decay reducing the late-time descent and spread.

N77-11005*# Boeing Commercial Airplane Co Seattle, Wash
A COMPUTATIONAL SYSTEM FOR AERODYNAMIC DESIGN AND ANALYSIS OF SUPERSONIC AIRCRAFT PART 2 USER'S MANUAL Final Report, Jan 1975 - Mar 1976

W D Middleton J L Lundry and R G Coleman Washington NASA Aug 1976 267 p refs (Contract NAS1-13732) (NASA-CR-2716 D6-43798-2) Avail NTIS HC A12/MF A01 CSCL 01A

An integrated system of computer programs was developed for the design and analysis of supersonic configurations. The system uses linearized theory methods for the calculation of surface pressures and supersonic area rule concepts in combination with linearized theory for calculation of aerodynamic force coefficients. Interactive graphics are optional at the user's request. This user's manual contains a description of the system, an explanation of its usage, the input definition and example output. Author

N77-11006*# Nielsen Engineering and Research, Inc., Mountain View Calif

CALCULATION OF THE LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF WING-FLAP CONFIGURATIONS WITH EXTERNALLY BLOWN FLAPS Final Report

Michael R Mendenhall, Selden B Spangler, Jack N Nielsen, and Frederick K Goodwin Washington NASA Sep 1976 143 p refs (Contract NAS1-13158)

(NASA-CR-2705) Avail NTIS HC A07/MF A01 CSCL 01A

A theoretical investigation was carried out to extend and improve an existing method for predicting the longitudinal characteristics of wing flap configurations with externally blown flaps (EBF). Two potential flow models were incorporated into the prediction method: a wing and flap lifting-surface model and a turbobfan engine wake model. The wing-flap model uses a vortex-lattice approach to represent the wing and flaps. The jet wake model consists of a series of closely spaced vortex rings normal to a centerline which may have vertical and lateral curvature to conform to the local flow field beneath the wing and flaps. Comparisons of measured and predicted pressure distributions, span load distributions on each lifting surface and total lift and pitching moment coefficients on swept and unswept EBF configurations are included. A wide range of thrust coefficients and flap deflection angles is considered at angles of attack up to the onset of stall. Results indicate that overall lift and pitching-moment coefficients are predicted reasonably well over the entire range. The predicted detailed load distributions are qualitatively correct and show the peaked loads at the jet impingement points, but the widths and heights of the load peaks are not consistently predicted. Author

N77-11007*# National Aeronautics and Space Administration Lewis Research Center Cleveland, Ohio

TWO-DIMENSIONAL COLD-AIR CASCADE STUDY OF A FILM-COOLED TURBINE STATOR BLADE 3 EFFECT OF HOLE SIZE ON SINGLE-ROW AND MULTIROW EJECTION

Herman W Prust Jr and Thomas P Moffitt Washington Oct 1976 33 p refs (NASA-TM-X-3442 E-8720) Avail NTIS HC A03/MF A01 CSCL 20D

The effect of coolant discharge on the aerodynamic performance of a film cooled turbine stator blade was determined. The blade had the same number, location and injection angle of coolant holes but the coolant hole diameters were one half that of a previously investigated blade. Otherwise the blades were the same. Tests with discharge from individual coolant rows and multiple coolant rows including full film discharge are studied. The results of the blade with smaller holes are reported and compared with the blades with larger holes. Author

N77-11008*# National Aeronautics and Space Administration
Lewis Research Center Cleveland Ohio

PERFORMANCE OF 115-PRESSURE-RATIO FAN STAGE AT SEVERAL ROTOR BLADE SETTING ANGLES WITH REVERSE FLOW

George Kovich and Royce D Moore Washington Nov 1976
91 p refs
(NASA-TM-X-3451 E-8571) Avail NTIS HC A05/MF A01
CSCL 21E

A 51 cm diameter low pressure ratio fan stage was tested in reverse flow. Survey flow data were taken over the range of rotative speed from 50 percent to 100 percent design speed at several rotor blade setting angles through both flat and feather pitch. Normal flow design values of pressure ratio and weight flow were 115 and 299 kg/sec with a rotor tip speed of 243.8 m/sec. The maximum thrust in reverse flow was 52.5 percent of design thrust in normal flow. Author

N77-11011# National Aerospace Lab Amsterdam (Netherlands)
Fluid Dynamics Div

CALCULATION OF THE FLOW AROUND A SWEEPED WING, TAKING INTO ACCOUNT THE EFFECT OF THE THREE-DIMENSIONAL BOUNDARY LAYER PART 1 WING WITH TURBULENT BOUNDARY LAYER

W J Piers G J Schipholt and B VandenBerg 27 May 1975
44 p refs

(Contract NIVR-1737)

(NLR-TR-75076-U) Avail NTIS HC A03/MF A01

The attached flow around swept wing was calculated with allowance for the effects of boundary layer and wake. The outer potential flow was computed with an adapted version of the NLR panel method. The displacement effect of the boundary layer and the wake was taken into account by the outflow concept. For the calculation of the three-dimensional turbulent boundary layer the method of Wesseling and Lindhout was used. The boundary layer calculations were based on measured pressure distributions while for the wake a crude estimation was made. It is concluded that the calculated potential flow, with allowance for viscous effects compares well with experimental results in terms of pressure and lift distribution. With regard to the computing time the potential flow program was about eight times faster than the boundary layer program. Author (ESA)

N77-11013# Hydronautics Inc Laurel Md
HIGH SPEED COMPUTER STUDIES OF VORTEX MOTIONS IN RELATION TO AIRCRAFT WAKE TURBULENCE Final Report

Clinton E Brown and Peter VanDyke Jan 1976 42 p refs
(Contract F44620-71-C-0080) AF Pro 07811
(AD-A024290 1R 7115-4 AFOSR 1481TR) Avail NTIS
HC A03/MF A01 CSCL 01,1

Computations are presented and compared with experimental data from other sources for basic and advanced problems in aircraft - wake vortex interactions. Results are presented for coalescence of corotation and counterrotating vortex groups and finally a complete high speed computer method is developed for simulating the roll reaction of an aircraft to the wake produced by a large aircraft with flaps deployed. Suggestions for improved experimental approaches are also appended. Author (GRA)

N77-11115*# IIT Research Inst Chicago Ill
WAVE PROPAGATION IN FIBER COMPOSITE LAMINATES, PART 2 Final Report, 1 Jul 1974 - 29 Feb 1976

I M Daniel and T Liber Jun 1976 135 p refs
(Contract NAS3-16766)
(NASA-CR-135086, IITRI-D6073-3-Pt-2) Avail NTIS
HC A07/MF A01 CSCL 11D

An experimental investigation was conducted to determine the wave propagation characteristics, transient strains and residual properties in unidirectional and angle-ply boron/epoxy and graphite/epoxy laminates impacted with silicone rubber projectiles at velocities up to 250 MS-1. The predominant wave is flexural

propagating at different velocities in different directions. In general measured wave velocities were higher than theoretically predicted values. The amplitude of the in-plane wave is less than ten percent of that of the flexural wave. Peak strains and strain rates in the transverse to the (outer) fiber direction are much higher than those in the direction of the fibers. The dynamics of impact were also studied with high speed photography. Author

N77-11116*# IIT Research Inst Chicago Ill
STRAIN RATE EFFECTS ON MECHANICAL PROPERTIES OF FIBER COMPOSITES, PART 3 Final Report, 1 Jul 1974 - 29 Feb 1976

I M Daniel and T Liber Jun 1976 49 p refs

(Contract NAS3-16766)

(NASA-CR-135087 IITRI-D6073-4)

Avail NTIS

HC A03/MF A01 CSCL 11D

An experimental investigation was conducted to determine the strain rate effects in fiber composites. Unidirectional composite specimens of boron/epoxy, graphite/epoxy, S-glass/epoxy and Kevlar/epoxy were tested to determine longitudinal, transverse and intralaminar (in-plane) shear properties. In the longitudinal direction the Kevlar/epoxy shows a definite increase in both modulus and strength with strain rate. In the transverse direction, a general trend toward higher strength with strain rate is noticed. The intralaminar shear moduli and strengths of boron/epoxy and graphite/epoxy show a definite rise with strain rate. Author

N77-11117*# Scientific Translation Service Santa Barbara Calif
CONTRIBUTIONS TO THE STUDY OF THE PHYSICAL PROPERTIES OF CARBON

F Carmona Washington NASA Nov 1976 193 p refs
Transl into ENGLISH of "Contributions a l Etude des Propriétés Physiques des Carbons" Doctoral Dissertation Bordeaux Univ
1976 p 1-178

(Contract NASw-2791)

(NASA-TT-F-17246) Avail NTIS HC A09/MF A01 CSCL 11D

A theoretical justification is given for old results of electron paramagnetic resonance. The evolution of the physical properties of carbon during carbonization is examined in light of recent theoretical and experimental studies on non-crystalline solids.

Author

N77-11118*# National Aeronautics and Space Administration
Lewis Research Center Cleveland Ohio

EFFECT OF FIBER DIAMETER AND MATRIX ALLOYS ON IMPACT-RESISTANT BORON/ALUMINUM COMPOSITES

David L McDanel and Robert A Signorelli Washington Nov 1976 38 p refs

(NASA-TN-D-8204, E-8648) Avail NTIS HC A03/MF A01
CSCL 11D

Efforts to improve the impact resistance of B/A are reviewed and analyzed. Nonstandard thin-sheet Charpy and Izod impact tests and standard full-size Charpy impact tests were conducted on composites containing unidirectional 0.10mm, 0.14mm and 0.20mm diameter boron fibers in 1100, 2024, 5052 and 6061 Al matrices. Impact failure modes of B/Al are proposed in an attempt to describe the mechanisms involved and to provide insight for maximizing impact resistance. The impact strength of B/Al was significantly increased by proper selection of materials and processing. The use of a ductile matrix and large diameter boron fibers gave the highest impact strengths. This combination resulted in improved energy absorption through matrix shear deformation and multiple fiber breakage. Author

N77-11019*# Transemanatics Inc Washington DC
TOWARD NEW HEIGHTS

B P Bugayev NASA Oct 1976 82 p refs Transl into ENGLISH of the mono K Novym Vystam (Novoye v Zhizni: Nauke, Tekhnike, Seriya Transport no 3) Moscow Znaniye

Press 1976 p 1-64
(Contract NASw-2792)
(NASA-TT-F-17248) Avail NTIS HC A05/MF A01 CSCL 01B

Aeroflot is not only the daily transport of hundreds of thousands of passengers but also the delivery of equipment, machinery parts and other cargoes to construction sites of the energy and industrial giants, flights with geologists in search of petroleum gas and other natural resources ice reconnaissance aid to fishermen on the open sea emergency flights to patients with a physician aboard the protection of forests against fires and much else The results are presented of accomplishing the tasks of the Ninth Five-year Plan and how Civil Aviation will develop in the future Author

N77-11020# National Aerospace Lab Amsterdam (Netherlands) Flight Div

THE ESTABLISHMENT OF SAFE SEPARATIONS BETWEEN AIRCRAFT IN FLIGHT

A Pool 1 Dec 1975 12 p Presented at the 28th Intern Air Safety Seminar Amsterdam 3-5 Nov 1975
(NLR-MP-75041-U) Avail NTIS HC A02/MF A01

The history of the use of models and statistical data for the assessment of separation standards is reviewed This work was mainly done by the ICAO Vertical Separation Panel the North Atlantic Systems Planning Group and the ICAO Panel for the Review of the General Concept of Separation After a brief description of the model and of the target level of safety plans for future work are indicated Author (ESA)

N77-11022# Naval Surface Weapons Center White Oak Md
AIRCRAFT GROUND FIRE SUPPRESSION AND RESCUE SYSTEMS CHARACTERISTICS OF KINEMATIC JET FUEL FIRES CASCADING AND ROD FUEL GEOMETRIES Final Report, Dec 1974 - Dec 1975

R S Alger F I Laughridge L L Wiltshire R G McKee (Stanford Res Inst Menlo Park Calif) W H Johnson (Stanford Res Inst, Menlo Park Calif) and N S Alvares (Stanford Res Inst, Menlo Park Calif) Wright-Patterson AFB Ohio DON Aircraft Ground Fire Suppression and Rescue Office Mar 1976 83 p refs Sponsored by DOD Aircraft Ground Fire Suppression and Rescue Office Prepared jointly by Stanford Res Inst Menlo Park Calif
(AD-A024447 DOD-AGFSRS-76-3) Avail NTIS HC A05/MF A01 CSCL 01/2

Based on a survey of kinematic fuel fires in aircraft accidents, two types i.e., cascade and rod fuel flows, were selected to theoretical and experimental examination The twofold objectives was (1) relate fire characteristics such as burning rate, radiation field and flame size to the fuel parameters the flowing conditions, and the environment and (2) determine the parameters and their degree of control required to achieve reproducible fires suitable for testing extinguishing agents equipment, and techniques Theoretical models based on steady, laminar, one-dimensional flow were developed GRA

N77-11023# RAND Corp Santa Monica Calif
A SECOND LOOK AT RELATIONSHIPS FOR ESTIMATING PEACETIME AIRCRAFT ATTRITION Interim Report
William E Mooz Feb 1976 65 p refs
(Contract F44620-73-C-0011)
(AD-A023681 R-1840-PR) Avail NTIS HC A04/MF A01 CSCL 01/3

The attrition experience of individual aircraft systems is found to change over the flying life of the system in such a way as to continually lower the attrition rate This process can be represented mathematically, and the resulting model used to project future losses for the system A study was made to evaluate the results of an earlier Rand study of peacetime aircraft attrition (RM-4840-PR August 1966) in light of 12 years of additional

flying hour and attrition data supplied by the Air Force Inspection and Safety Center The earlier study resulted in sufficient understanding of the attrition process to develop estimating methodologies that were adopted by the Air Force in official publications and that are still in use The conceptual bases for the findings of the first study are discussed, and in conjunction with statistical parameters and an examination of some typical projections the utility of the method is evaluated Author (GRA)

N77-11024# Westinghouse Defense and Electronic Systems Center, Baltimore Md Aerospace and Electronic Systems Div
FINAL APPROACH PERFORMANCE MONITOR Final Report

I T Basil Jul 1976 189 p
(Contract DOT-FA72WA-2837)
(AD-A028513/0 FAA-RD-76-117 Rept-75-0280A) Avail NTIS HC A09/MF A01 CSCL 17/7

The objectives the system design goals, the hardware developed, and the laboratory test results of an instrument landing system (ILS) performance monitor are stipulated This new measuring system makes angular measurements of the angular deviation from the glidepath of an aircraft on a final approach Measurements are made once every airport surveillance radar (ASR) scan The signal used for this measurement is the aircraft's transponder reply to the ASR interrogation A fixed monopulse monitoring antenna measures the angular position of the aircraft relative to the antenna boresight Since the antenna is boresighted along the glidepath computations can determine the deviation of the aircraft from the glideslope The technique is very precise in measuring angular deviation from antenna boresight its range measuring accuracy is limited by the inherent jitter in the transponder reply Author

N77-11029*# Transemanatics, Inc., Washington, D C
CALCULATION OF MULTI-CONTOUR THIN-WALLED STRUCTURES BY THE METHOD OF SECTIONS
V G Shatayev NASA Nov 1976 15 p refs Transl into ENGLISH from Izv Vysshikh Uchebn Zavedenii Aviat Tekhn (Kazan) no 2, Feb 1976 p 117-123
(Contract NASw-2792)
(NASA-TT-F-17284) Avail NTIS HC A02/MF A01 CSCL 01C

In calculating thin-walled airframe structures of the type used in the wings and tails of aircraft, the hypothesis of the invariability of the shape of the contour of the cross sections during deformation is widespread Many theoretical and experimental studies have shown that it applies in the study of the majority of problems of strength of wing and tail assemblies The method of final sums is used in this article to obtain the numerical solution for a cantilevered thin-walled beam Matrix formulation of basic relationships, equations for numerical solution of a cantilevered stringer and methods of sections are discussed Author

N77-11030*# Aerospace Systems, Inc Burlington, Mass
DISPLAY/CONTROL REQUIREMENTS FOR VTOL AIRCRAFT Interim Technical Report
William C Hoffman Renwick E Curry (MIT Cambridge) David L Kleinman (Connecticut Univ Storrs) Walter M Hollister (MIT Cambridge) and Laurence R Young (MIT, Cambridge) Aug 1975 273 p refs
(Contract NAS1-13653)
(NASA-CR-145026 ASI-TR-75-26) Avail NTIS HC A12/MF A01 CSCL 01C

Quantative metrics were determined for system control performance workload for control, monitoring performance, and workload for monitoring Pilot tasks were allocated for navigation and guidance of automated commercial V/STOL aircraft in all weather conditions using an optimal control model of the human operator to determine display elements and design A H

N77-11031*# National Aeronautics and Space Administration
Langley Research Center Langley Station Va
**PRELIMINARY SIZING AND PERFORMANCE EVALUATION
OF SUPERSONIC CRUISE AIRCRAFT**
D E Fetterman Jr Sep 1976 80 p refs
(NASA-TM-X-73936) Avail NTIS HC A05/MF A01 CSCL
01C

The basic processes of a method that performs sizing operations on a baseline aircraft and determines their subsequent effects on aerodynamics propulsion weights and mission performance are described. The input requirements of the associated computer program are defined and its output listings explained. Results obtained by applying the method to an advanced supersonic technology concept are discussed. These results include the effects of wing loading thrust to weight ratio and technology improvements on range performance and possible gains in both range and payload capability that become available through growth versions of the baseline aircraft. The results from an in depth contractual study that confirm the range gain predicted for a particular wing loading thrust-to-weight ratio combination are also included. Author

N77-11032*# Lockheed-Georgia Co Marietta
**PROGRAM FOR ESTABLISHING LONG-TIME FLIGHT
SERVICE PERFORMANCE OF COMPOSITE MATERIALS IN
THE CENTER WING STRUCTURE OF C-130 AIRCRAFT
PHASE 4 GROUND/FLIGHT ACCEPTANCE TESTS**
W E Harvill and J A Kizer Sep 1976 153 p refs
(Contract NAS1-11100)
(NASA-CR-145043 LG76ER0095) Avail NTIS
HC A08/MF A01 CSCL 01C

The advantageous structural uses of advanced filamentary composites are demonstrated by design fabrication and test of three boron epoxy reinforced C-130 center wing boxes. The advanced development work necessary to support detailed design of a composite reinforced C-130 center wing box was conducted. Activities included the development of a basis for structural design selection and verification of materials and processes manufacturing and tooling development and fabrication and test of full-scale portions of the center wing box. Detailed design drawings and necessary analytical structural substantiation including static strength fatigue endurance flutter and weight analyses are considered. Some additional component testing was conducted to verify the design for panel buckling and to evaluate specific local design areas. Development of the cool tool restraint concept was completed and bonding capabilities were evaluated using full-length skin panel and stringer specimens. Author

N77-11033*# National Aeronautics and Space Administration
Langley Research Center Langley Station Va
**LANDING PRACTICES OF GENERAL AVIATION PILOTS IN
SINGLE-ENGINE LIGHT AIRPLANES**
Maxwell W Goode Thomas C OBryan Kenneth R Yenni Robert
L Cannaday and Marna H Mayo Washington Oct 1976
50 p refs Technical film supplement L-1208 is available on
loan from Langley Research Center Attn Photographic Branch
mail stop 425 Hampton Va 23665
(NASA-TN-D-8283 L-10878) Avail NTIS HC A03/MF A01
CSCL 05H

The methods and techniques used by a group of general aviation pilots during the landing phase of light airplane operations are documented. The results of 616 landings made by 22 pilots in 2 modern four-place single-engine flight airplanes (one having a low wing and the other a high wing) are presented. The landings were made on both a long runway (1524 m (5000 ft)) and a short runway (762 m (2500 ft)) both runways were considered typical of those used in general aviation. The results generally show that most of the approaches were fast with considerable floating during the flares and with touchdowns that were relatively flat or nose low. Author

N77-11035# Rockwell International Corp Columbus Ohio
Missile Systems Div
**CONCEPTUAL DESIGNS FOR A MODULAR REMOTELY
PILOTED VEHICLE Final Report, 2 Dec 1974 - 26 Nov
1975**

Francis L Goebel Kirsey O Smith and Frederick W Hessman
Jan 1976 279 p refs
(Contract F33615-75-C-3036 AF Proj 1989)
(AD-A023844 C75-1443/034C AFFDL-TR-75-162) Avail
NTIS HC A13/MF A01 CSCL 01/3

The application of the modular design approach to remotely piloted vehicles is described. It is shown that by modular exchange of structural and equipment components a basic vehicle can be configured to perform low level recce and strike medium altitude EW high altitude recce and tactical air-to-air missions. Two basic vehicle configuration design concepts which differ primarily in engine installation arrangement (nacelle versus internal) are presented. The design approach using the nacelle-mounted engine is shown to be superior and to provide the best basis for a technology evaluator or demonstrator. GRA

N77-11036# Douglas Aircraft Co Inc Long Beach Calif
DEVELOPMENT OF A GRAPHITE HORIZONTAL STABILIZER
Final Report, 3 Nov 1969 - 31 Aug 1975
George M Lehman M Ashizawa M J Gallippi A V Hawley
and C A VanPappelendam Mar 1976 85 p
(Contract N00156-70 C-1321 WF41422206)
(AD-A023767 MDC-J6902 NADC-76078-30) Avail NTIS
HC A05/MF A01 CSCL 01/3

A summary of the design synthesis structural development testing tooling manufacturing and ground testing of an advanced composite horizontal stabilizer for the A-4 Skyhawk is presented. The stabilizer utilized Narmco 5206 graphite-epoxy as the primary load-bearing structural material (58.5 percent by weight). The most significant problem encountered was the development of structurally efficient joints. In ground tests the graphite stabilizer successfully sustained design ultimate loads and subsequently sustained two lifetimes of fatigue spectrum loads. A positive margin of safety of 12 percent was indicated in a final ultimate-strength test after completion of the fatigue test. A flutter analysis based on the natural modes and frequencies of the graphite stabilizer indicated an improvement in empennage flutter speed. A weight reduction of 26.2 percent was achieved in comparison to the existing metal stabilizer. GRA

N77-11037# ARO Inc Arnold Air Force Station Tenn
A WIND TUNNEL CAPTIVE AIRCRAFT TESTING TECHNIQUE
Final Report, 1 Jul 1974 - 30 Jun 1975
R W Butler AEDC Apr 1976 37 p refs
(ARO Proj P32A-33A ARO Proj P41T-78A)
(AD-A023690 ARO-PWT-TR-75-80 AEDC-TR-76-22) Avail
NTIS HC A03/MF A01 CSCL 01/3

A captive aircraft testing technique has been developed for use in the 16 ft wind tunnels at the Arnold Engineering Development Center (AEDC). With the captive system an aircraft motion study may be conducted in the wind tunnel with the tunnel acting as an analog forcing function. The large static aerodynamic data matrix normally required for a motion study has been alleviated. The system validity is established by a comparison of F-15 aircraft motion generated in the wind tunnel with flight motion of a NASA 3/8-scale F-15 Remotely Piloted Vehicle (RPV). Good agreement between the longitudinal and lateral/directional motions of the model was achieved in the absence of RPV unsteady aerodynamics (wing buffet). The captive technique ability to efficiently define changes in aircraft flight characteristics resulting from different external store configurations is demonstrated. Author (GRA)

N77-11038# Naval Air Development Center Warminster Pa
Air Vehicle Technology Dept
**CATAPULT LAUNCH FATIGUE INVESTIGATION OF THE
MODEL S-2 E AIRPLANE Final Report**
H D Lystad 31 Dec 1975 58 p refs
(AD-A024071 NADC-75368-30) Avail NTIS
HC A04/MF A01 CSCL 01/3

A laboratory fatigue investigation was performed on an S-2 E fuselage with reinforced catapult keel beam and holdback carry through structure to determine if it could sustain the loads associated with 3 000 catapult launches. The bulkhead at fuselage station 206 failed after 5 690 test cycles of the catapult start of run condition. Using a test scatter factor of 2, this is equivalent to 2 845 service catapult launches. The test article experienced 419 service catapult launches prior to reinforcement, which when added to the test results provides for a service catapult launch life in excess of 3 000 launches. The holdback release condition test was discontinued after 10 000 test cycles with no failures. Again using a test scatter factor of 2, this is equivalent to 5,000 service catapult launches. Author (GRA)

N77-11039# Army Aviation Engineering Flight Activity Edwards AFB Calif
ARMY PRELIMINARY EVALUATION YOH-58A HELICOPTER WITH A FLAT-PLATE CANOPY Final Report
James R Arnold and Gary L Skinner Dec 1975 45 p refs
(AD-A024501 USAAEFA-75-20) Avail NTIS
HC A03/MF A01 CSCL 01/3

A limited evaluation of the performance and handling qualities of the OH-58A helicopter was conducted to determine the effects of a four-plane flat-plate canopy installation. Testing was conducted at the Bell Helicopter Company flight test facility at Arlington Texas from 25 October through 4 November 1975. Personnel from the United States Army Aviation Engineering Flight Activity conducted 11 test flights for a total of 6 5 productive test flight hours. The evaluation revealed a loss in airspeed of 2 and 6 knots at the airspeed for maximum continuous power and a loss in range of 8 and 23 nautical miles at the cruise airspeed (forward and aft center-of-gravity configurations respectively). The noticeable changes in the handling qualities were a slight increase in the nose-down pitching rate following a sudden loss of power (more pronounced for the forward center-of-gravity configuration) and a slight increase in the dihedral effect of the helicopter. The flat-plate canopy installation resulted in a slight reduction in the field of view, but visibility was improved due to the optical clarity of the flat-plate. The installation of glare shields between the chin bubble and canopy significantly reduced the canopy reflections during both day and night tests. One shortcoming was noted during this evaluation but cannot be attributed to the flat-plate canopy installation. Author (GRA)

N77-11040# Naval Air Development Center Warminster Pa
Vehicle Technology Dept
**FATIGUE INVESTIGATION OF THE E-2B/C NOSE LANDING
GEAR Final Report**
H D Lystad 31 Dec 1975 65 p refs
(AD-A024072 NADC-75369-30) Avail NTIS
HC A04/MF A01 CSCL 01/3

A laboratory fatigue investigation was performed on an E-2B and an E-2C nose landing gear to determine whether the authorized limit of 650 catapult launches could be extended. The starboard holdback lug of the E-2B nose landing gear with modified drag brace attachment lugs failed after the application of 3 336 test cycles. Using a test scatter factor of two, this is equivalent to 1 668 service catapult launches. The outer cylinder of the E-2C shock strut assembly cracked under the packing nut after completion of 7 430 test cycles. Again using a test scatter factor of two, this is equivalent to 3 715 service catapult launches. Author (GRA)

N77-11041# Bell Helicopter Co., Fort Worth, Tex
**HELICOPTER RELIABILITY GROWTH EVALUATION Final
Report**
G S Conway Apr 1976 170 p refs
(Contract DAAJ02-73-C-0097, DA Proj 1F1-63204-DB-38)
(AD-A025265 USAAMRDL-TR-75-53) Avail NTIS
HC A08/MF A01 CSCL 01/3

This report presents the results and data resulting from a research evaluation made of the reliability growth characteristics of the development and early production of UH-1D and AH-1G helicopters. The major subjects covered by the technique and backed by research are off-board MTBF reliability (MTBF) growth versus test time and reliability growth versus calendar time. A tentative technique for predicting helicopter reliability growth applicable to reliability program planning and management is also presented based on the results of the research. An example of the technique procedures applied to a hypothetical helicopter is also presented. Author (GRA)

N77-11042# Massachusetts Inst of Tech Canbridge Aeroelastic and Structures Research Lab
**ANALOG COMPUTATION ASSESSMENT OF THE RISK OF
STRUCTURAL FAILURE DUE TO CRACK GROWTH UNDER
RANDOM LOADING Final Report, Feb 1974 - May 1975**
Oscar Orringer, Richard F Harris and John F McCarthy, Jr
Oct 1975 98 p refs
(Contract F33615-74-C-3046 AF Proj 1929)
(AD-A025266 ASRL-TR-179-1 AFFDL-TR-75-123) Avail
NTIS HC A05/MF A01 CSCL 01/3

Risks of fracture were computed from a Monte Carlo simulation of the Paris equation for crack growth rate. The simulation covered a total number of load events approximately equivalent to the estimated useful service life for a typical fighter airplane. The simulation was implemented by development of a computation technique based on the analog computer. Approximately 200 simulations were run for each of 11 assumed initial crack sizes with the loading represented by a random noise signal filtered through a track-hold circuit to match a stress range exceedance distribution derived from an acceleration peak exceedance curve for the typical aircraft fleet. The resulting data were sampled at four fractions of simulated service life and then reduced to four final crack size histograms for each initial crack size. The raw data histograms were used to estimate parameter values for three-parameter Weibull distributions for final crack size in each case and a regression analysis was performed to correlate the distributions for risk analysis. Mathematical risks of structural failure were computed and compared for several combinations of assumptions about the loading and the initial crack size distributions. Author (GRA)

N77-11043# Aerospace Medical Research Labs Wright-Patterson AFB Ohio
**INFLUENCE OF AIRCRAFT ANGLE OF ATTACK ON HIGH
G COCKPIT DESIGN**
Philip V Kulwicki Mar 1976 31 p refs
(AF Proj 7184)
(AD-A025083 AMRL-TR-75-124) Avail NTIS
HC A03/MF A01 CSCL 01/3

The effects of aircraft angle of attack and flight path acceleration during high G fighter maneuvering on the position of the resultant G relative to the pilot are examined by means of a computer simulated dogfight engagement. It is demonstrated that a transient shifting in position of the resultant G relative to an aircraft vertical reference is correlated with variations in flight path acceleration which occur due to pilot actuation of controls with attendant changes in flight path characteristics. Although time intervals during high G turns are noted wherein high values for aircraft angle of attack coincide with high values for the position of resultant G forward of aircraft vertical, these cases generally occur at subsonic (M equal to or less than 0.7) airspeeds and for the best case for which the maximum power throttle setting is elected. For high G turns at transonic and supersonic speeds the associated angle of attack is substantially reduced as is the maximum inclination of resultant G forward of vertical for the best case of maximum power setting. Application of

speed brakes or selection of an intermediate power setting has the effect of shifting the G-vector aft. It is concluded that the arbitrary addition of a large angle equal to the aircraft angle of attack to the ejection seat back angle to provide added pilot protection against high G forces is not warranted. Author (GRA)

N77-11044*# National Aeronautics and Space Administration
Ames Research Center, Moffett Field, Calif
**RATIONALE AND DESCRIPTION OF A COORDINATED
COCKPIT DISPLAY FOR AIRCRAFT FLIGHT MANAGE-
MENT**

Daniel L Baty Washington Nov 1976 18 p refs
(NASA-TM-X-3457, A-6663) Avail NTIS HC A02/MF A01
CSCL 01C

The design for aircraft cockpit display systems is discussed in detail. The system consists of a set of three beam penetration color cathode ray tubes (CRT). One of three orthogonal projects of the aircraft's state appears on each CRT which displays different views of the same information. The color feature is included to obtain visual separation of information elements. The colors of red, green and yellow are used to differentiate control performance and navigation information. Displays are coordinated in information and color. B B

N77-11045# Lockheed-Georgia Co Marietta
**V/STOL AIRCRAFT NOISE PREDICTION (JET PROPUL-
SION) Final Report, Jun 1974 - Jun 1975**

N N Reddy D F Blakney J G Tibbets and J S Gibson
Jun 1975 309 p refs Supersedes FAA-RD-73-145
(Contract DOT-FA72WA-3099)
(AD-A028765/6, LG75ER0054 FAA-RD-75-125
FAA-RD-73-145) Avail NTIS HC A14/MF A01 CSCL 01/3

A computer program is presented for predicting the noise levels of V/STOL aircraft with jet-propulsive-lift systems. Using the equations developed in this report the noise levels may also be estimated with hand calculations. Vectored thrust externally blown flap upper surface blown flap internally blown flap and augmentor wing are the propulsive-lift concepts considered. Semi-empirical equations are derived using the test results and theories for the following aircraft noise sources. Internal engine jet excess (core engine) high-lift system, airframe and auxiliary power unit. The computer program predicts the perceived noise levels and tone corrected perceived noise levels for V/STOL aircraft at any specified sideline distance for known geometrical and operational parameters. Author

N77-11046*# AiResearch Mfg Co Phoenix Ariz
**COMPRESSOR BLADE SETTING ANGLE ACCURACY
STUDY, VOLUME 1 Final Report**

F F Holman and J R Kidwell Jun 1976 107 p refs Sponsored by Army Air Mobility Res and Develop Lab Moffett Field Calif 2 Vol
(Contract NAS3-18024)
(NASA-CR-135068-Vol-1 AiResearch-73-311305-Vol-1) Avail NTIS HC A06/MF A01 CSCL 21E

The aerodynamic test of a small single stage highly loaded axial flow transonic compressor is covered. The stage was modified by fabricating a 24 blade rotor with mis-set blades in a repeating pattern - two degrees closed from nominal, two degrees open from nominal and nominal. The unit was instrumented to determine overall performance and average blade element data. High-response dynamic pressure probes were installed to record pressure patterns at selected points in the flowpath. Testing was conducted at speeds from 70 to 94% of design equivalent speed with a conventional casing and also with circumferential grooves over the rotor tip. Testing indicated severe performance penalties were incurred as a result of the mis-set blading. Lower flow pressure ratio, and efficiency were observed for the stage with or without casing treatment. Periodic pressure variations were detected at every location where high response pressure sensors were located and were directly related to blading geometry. Author

N77-11047*# AiResearch Mfg Co Phoenix, Ariz
**COMPRESSOR BLADE SETTING ANGLE ACCURACY
STUDY, VOLUME 2 DATA COMPILATION Final Report**
F F Holman and J R Kidwell Jun 1976 133 p Sponsored by Army Air Mobility Res and Develop Lab Moffett Field Calif 2 Vol
(Contract NAS3-18024)
(NASA-CR-135068-Vol-2 AiResearch-73-311305-Vol-2) Avail NTIS HC A07/MF A01 CSCL 21E
For abstract see N77-11046

N77-11048*# AiResearch Mfg Co Phoenix Ariz
SMALL AXIAL COMPRESSOR TECHNOLOGY, VOLUME 1
F F Holman, J R Kidwell and T C Ware Jun 1976 185 p refs Sponsored in part by Army
(Contract NAS3-17846)
(NASA-CR-134827-Vol-1 AiResearch-74-310862-Vol-1) Avail NTIS HC A05/MF A01 CSCL 21E

A scaled single-stage, highly-loaded axial-flow transonic compressor was tested at speeds from 70 to 110% design equivalent speed to evaluate the effects of scaling compromises and the individual and combined effects of rotor tip running clearance and rotor shroud casing treatment on the overall and blade element performance. At design speed and 1% tip clearance the stage demonstrated an efficiency of 83.2% at 96.4% design flow and a pressure ratio of 1.865. Casing treatment increased design speed surge margin 2.0 points to 12.8%. Overall performance was essentially unchanged. An increase in rotor running clearance to 2.2% with smooth casing reduced design speed peak efficiency 5.7 points flow by 7.4% pressure ratio to 1.740 and surge margin to 5.4%. Reinstalling casing treatment regained 3.5 points in design speed peak efficiency. 4.7% flow increased pressure ratio to 1.800 and surge margin to 8.7%. Author

N77-11049*# AiResearch Mfg Co Phoenix Ariz
SMALL AXIAL COMPRESSOR TECHNOLOGY, VOLUME 2
Final Report
F F Holman, J R Kidwell and T C Ware Jun 1976 329 p Sponsored in part by Army
(Contract NAS3-17846)
(NASA-CR-134827-Vol-2 AiResearch-74-310862-Vol-2) Avail NTIS HC A15/MF A01 CSCL 21E

Complete computer printout data are presented and supporting tests discussed in Volume 1. Author

N77-11050*# National Aeronautics and Space Administration
Lewis Research Center Cleveland Ohio
**SIMULATION OF FLIGHT-TYPE ENGINE FAN NOISE IN
THE NASA-LEWIS 9X15 ANECHOIC WIND TUNNEL**
M F Heidmann and D A Dietrich Nov 1976 24 p refs Presented at the 92d Meeting of the Acoust Soc of Am San Diego, Calif 16-19 Nov 1976
(NASA-TM-X-73540 E-8972) Avail NTIS HC A02/MF A01 CSCL 20A

Flight type noise as contrasted to the usual ground static test noise exhibits substantial reductions in the time unsteadiness of tone noise and in the mean level of tones calculated to be nonpropagating or cut-off. A model fan designed with cutoff of the fundamental tone was acoustically tested in the anechoic wind tunnel under both static and tunnel flow conditions. The properties that characterize flight type noise were progressively simulated with increasing tunnel flow. The distinctly lobed directivity pattern of propagating rotor/stator interaction modes was also observed. Excess noise attributed to the ingestion of the flow disturbances that prevail near most static test facilities is substantially reduced with tunnel flow. Author

N77-11051*# National Aeronautics and Space Administration
Lewis Research Center Cleveland, Ohio
**EFFECTS OF FORWARD VELOCITY ON NOISE FOR A J85
TURBOJET ENGINE WITH MULTITUBE SUPPRESSOR
FROM WIND TUNNEL AND FLIGHT TESTS**

James R Stone Jeffrey H Miles and Noel B Sargent Nov 1976 30 p refs Presented at the 92d Meeting of the Acoustical Soc of Am San Diego Calif 16-19 Nov 1976 (NASA-TM-X-73542 E-8974) Avail NTIS HC A03/MF A01 CSCL 20A

Flight and wind tunnel noise tests were conducted using a J85 turbojet engine as a part of comprehensive programs to obtain an understanding of forward velocity effects on jet exhaust noise. Nozzle configurations of primary interest were a 104-tube suppressor with and without an acoustically-treated shroud. The installed configuration of the engine was as similar as possible in the flight and wind tunnel tests. Exact simultaneous matching of engine speed exhaust velocity and exhaust temperature was not possible and the wind tunnel maximum Mach number was approximately 0.27 while the flight Mach number was approximately 0.37. The nominal jet velocity range was 450 to 640 m/sec. For both experiments background noise limited the jet velocity range for which significant data could be obtained. In the present tests the observed directivity and forward velocity effects for the suppressor are more similar to predicted trends for internally-generated noise than unsuppressed jet noise.

Author

N77-11052*# National Aeronautics and Space Administration
Lewis Research Center Cleveland Ohio
**MACROSCOPIC STUDY OF TIME UNSTEADY NOISE OF
AN AIRCRAFT ENGINE DURING STATIC TESTS**

B J Clark M F Heidmann and W J Kreim Nov 1976 14 p refs Presented at the 92d Meeting of the Acoustical Soc of Am San Diego Calif 16-19 Nov 1976 (NASA-TM-X-73556 E-8995) Avail NTIS HC A02/MF A01 CSCL 20A

Static tests of aircraft engines can exhibit greater than 10 db random unsteadiness of tone noise levels because flow disturbances that prevail near test site facilities are ingested. Presumably such changes are related to installation and test site features. Some properties of unsteady noise observed during tests of a Lycoming YF-102 turbofan engine are presented. Time and spatial variations in tone noise obtained from closely spaced far field and inlet duct microphones are displayed. Long to extremely short intermittent tone bursts are observed. Unsteadiness of the tone, its harmonics, and the broadband noise show little similarity. In the far field identity of tone bursts is retained over a directivity angle of less than 10 deg. In the inlet duct tone bursts appear to propagate axially but exhibit little circumferential similarity. They show only slight relationship to tone bursts observed in the far field. The results imply an intermittent generation of random mixtures of propagating duct modes.

Author

N77-11053*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland Ohio
**CORE NOISE SOURCE DIAGNOSTICS ON A TURBOFAN
ENGINE USING CORRELATION AND COHERENCE
TECHNIQUES**

Allen Karchmer and Meyer Reshotko 1976 27 p refs Presented at the ninety-second Meeting of the Acoust Soc of Am San Diego Calif 16-19 Nov 1976 (NASA-TM-X-73535 E-8961) Avail NTIS HC A03/MF A01 CSCL 21E

Fluctuating pressure measurements at several locations within the core of a turbofan engine were made simultaneously with far field acoustic measurements. Correlation and coherence techniques were used to determine the relative amplitude and phase relationships between core pressures at these various locations and between the core pressures and far field acoustic pressure. The combustor is a low frequency source region for acoustic propagation through the core nozzle and out to the far field. The relation between source pressure and the resulting

sound pressure involves a 180 degree phase shift and an amplitude transfer function which varies approximately as frequency squared. This is consistent with a simplified model using fluctuating entropy as a source term.

Author

N77-11054*# AiResearch Mfg Co Phoenix Ariz
**STUDY OF SMALL TURBOFAN ENGINES APPLICABLE TO
SINGLE-ENGINE LIGHT AIRPLANES Final Report**

G L Merrill Sep 1976 118 p refs (Contract NAS2-8582) (NASA-CR-137944 AiResearch-76-211893) Avail NTIS HC A06/MF A01 CSCL 21E

The design efficiency and cost factors are investigated for application of turbofan propulsion engines to single engine general aviation light airplanes. A companion study of a hypothetical engine family of a thrust range suitable to such aircraft and having a high degree of commonality of design features and parts is presented. Future turbofan powered light airplanes can have a lower fuel consumption lower weight reduced airframe maintenance requirements and improved engine overhaul periods as compared to current piston engined powered airplanes. Achievement of compliance with noise and chemical emission regulations is expected without impairing performance operating cost or safety.

Author

N77-11055*# National Aeronautics and Space Administration
Washington D C

**AIRCRAFT FUEL CONSERVATION TECHNOLOGY TASK
FORCE REPORT, SEPTEMBER 10, 1975**

10 Sep 1975 141 p (NASA-TM-X-74295) Avail NTIS HC A07/MF A01 CSCL 21E

An advanced technology program is described for reduced fuel consumption in air transport. Cost benefits and estimates are given for improved engine design and components, turboprop propulsion systems, active control systems, laminar flow control and composite primary structures.

A H

N77-11057*# National Aeronautics and Space Administration
Lewis Research Center Cleveland Ohio
**METHOD OF DISCRETE MODELING AND ITS APPLICATION
TO ESTIMATION OF TF30 ENGINE VARIABLES**

Dale J Arpas and William M Bruton Oct 1976 40 p refs (NASA-TM-X-3443 E-8560) Avail NTIS HC A03/MF A01 CSCL 21E

A method of discrete modeling is presented that effectively isolates steady state model accuracy from dynamic model accuracy. The steady state model may be generated from the engine design equations with any desired degree of accuracy. The dynamic model is generated by applying a step disturbance of a manipulated variable to an open loop engine simulation. The sampled response of the variable is combined with the steady state model's response to form a set of weighting factors. These weighting factors are then used to weight past values of the manipulated variable, thus forming the dynamic model. The method is used to estimate various TF30-P-3 engine variables. A dynamic trim function is developed to compensate for the dynamic nonlinearities of the variables as well as for inaccuracies in dynamic definition. The trim function is shown to be related to the square root of the sum of the squares of the weighting factors obtained at various engine operating conditions. Finally, the estimation of variables without dynamic modeling is discussed.

Author

N77-11059# Purdue Univ Lafayette, Ind
**PROJECT SQUID A COOPERATIVE PROGRAM OF
FUNDAMENTAL RESEARCH RELATED TO JET PROPULSION
Semiannual Progress Report, 30 Sep 1975 - 1 Apr 1976**

1 Apr 1976 118 p refs (Contract N00014-75-C-1143 NR Proj 078-038 Proj SQUID) (AD-A024004) Avail NTIS HC A06/MF A01 CSCL 21/5

Reports of progress during the past six months on the 21 research programs comprising Project SQUID are presented. The research programs fall into the areas of Aerodynamics and Turbomachinery Combustion and Chemical Kinetics Measurements and Turbulence. Project SQUID is a cooperative program of basic research related to jet propulsion. It is administered by Purdue University and sponsored by the Office of Naval Research. Author (GRA)

N77-11061# New York Univ Westbury Aerospace and Energetics Lab
INVESTIGATION OF SLOT COOLING FOR HIGH-SPEED AIRCRAFT Final Report, 1 Aug 1971 - 30 Sep 1975
 Antonio Ferri Dec 1975 23 p refs
 (Grant AF-AFOSR-2167-72, AF Proj 6813 AF Proj 9781)
 (AD-A024316 AFOSR-76-0505TR) Avail NTIS
 HC A02/MF A01 CSCL 21/5

Active film cooling for gas turbine blades has been investigated. Upstream injection at the leading edge and tangential injection downstream has been used to protect the blade. GRA

N77-11062# Engelhard Minerals and Chemicals Corp Edison NJ Research and Development Dept
HIGH TEMPERATURE THERMOCOUPLE SYSTEM FOR ADVANCED AIRCRAFT TURBINE ENGINES Final Technical Report, 1 Aug 1974 - 31 Dec 1975
 D A Toenshoff and E D Zysk Wright-Patterson AFB Ohio AFAPL 31 Dec 1975 109 p refs
 (Contract F33615-74-C-2069 AF Proj 3066)
 (AD-A025500 AFAPL-TR-75-108) Avail NTIS
 HC A06/MF A01 CSCL 21/5

This is a final report covering the development of a temperature measuring system for the very high temperature gas streams found in advanced jet engines. The measurement system is a thermocouple probe assembly suitable for interfacing to the Detroit Diesel-Allison GMA 200 Joint Technology Demonstration Engine. Average temperatures of the order of 2600-2700F (1425-1480C) will have to be measured and it is anticipated that hot spots to 3000F (1650C) will be encountered. This study covered the selection of an optimum thermocouple (Pt-40% Rh vs Pt-0.6% ThO₂), compatible compensating extension lead wire (base metal) usable to around 750C in air (Nichrome vs EA 9R-682), high temperature resisting sheath and shield tube material (Pt-0.6% ThO₂) crushable MgO insulation design of a temperature probe using the optimum materials and vibration testing at 1450C of one of the finished probes. The selected probe passed the high temperature vibration test successfully. GRA

N77-11063*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
SIMULATION OF AN AUTOMATICALLY-CONTROLLED STOL AIRCRAFT IN A MICROWAVE LANDING SYSTEM MULTIPATH ENVIRONMENT
 Mitsuhiro Toda, Stuart C Brown and Clifford N Burrous Jul 1976 42 p refs
 (NASA-TM-X-73154, A-6693) Avail NTIS HC A03/MF A01 CSCL 17G

The simulated response is described of a STOL aircraft to Microwave Landing System (MLS) multipath errors during final approach and touchdown. The MLS azimuth elevation and DME multipath errors were computed for a relatively severe multipath environment at Crissy Field California utilizing an MLS multipath simulation at MIT Lincoln Laboratory. A NASA/Ames six-degree-of-freedom simulation of an automatically-controlled deHavilland C-8A STOL aircraft was used to determine the response to these errors. The results show that the aircraft response to all of the Crissy Field MLS multipath errors was small. The small MLS azimuth and elevation multipath errors did not result in any discernible aircraft motion and the aircraft response to the relatively large (200-ft (61-m) peak) DME multipath was noticeable but small. Author

N77-11064*# Boeing Aerospace Co Seattle Wash
PRELIMINARY DESIGN-LIFT/CRUISE FAN RESEARCH AND TECHNOLOGY AIRPLANE FLIGHT CONTROL SYSTEM Final Report
 Philip Gotlieb, George E Lewis, and Leo J Little Nov 1976 106 p refs
 (Contract NAS2-9177)
 (NASA-CR-137971 D180-20216-1) Avail NTIS
 HC A06/MF A01 CSCL 01C

This report presents the preliminary design of a stability augmentation system for a NASA V/STOL research and technology airplane. This stability augmentation system is postulated as the simplest system that meets handling qualities levels for research and technology missions flown by NASA test pilots. The airplane studied in this report is a T-39 fitted with tilting lift/cruise fan nacelles and a nose fan. The propulsion system features a shaft interconnecting the three variable pitch fans and three power plants. The mathematical modeling is based on pre-wind tunnel test estimated data. The selected stability augmentation system uses variable gains scheduled with airspeed. Failure analysis of the system illustrates the benign effect of engine failure. Airplane rate sensor failure must be solved with redundancy. Author

N77-11065# Rockwell International Corp Columbus Ohio Aircraft Div
DESIGN AND FABRICATION OF AN 8000 PSI CONTROL-BY-WIRE ACTUATOR FOR FLIGHT TESTING IN A T-2 C AIRPLANE Final Report, 28 Mar 1975 - 5 Jan 1976
 Joseph N Demarchi and Robert K Haning Jan 1976 45 p refs
 (Contract N62269-75-C-0311)
 (AD-A024487 NR76H-1, NADC-76049-30) Avail NTIS
 HC A03/MF A01 CSCL 01/3

This report describes the design and fabrication of an 8000 psi control-by-wire hydraulic rudder actuator for future flight testing in a T-2C airplane. Actuator output is commanded by a single stage spool/sleeve valve driven directly by a permanent magnet force motor. Actuator design criteria were based on T-2C aerodynamic considerations and envelope constraints. A system analysis was conducted to determine heat dissipation and hydraulic line sizes and routing. Modifications required on the T-2C airplane to accommodate the test system installation were outlined. Author (GRA)

N77-11066# Instrument Flight Center Randolph AFB Tex
HELICOPTER YAW AXIS AUGMENTATION INVESTIGATION
 William E Clark and Gabriel P Intano Mar 1976 147 p
 (AD-A024512 IFC-TR-76-3) Avail NTIS HC A07/MF A01 CSCL 01/3

This investigation was conducted to document changes in pilot performance and activity resulting from augmentation of the helicopter yaw axis. Subject pilot opinions regarding workload and pilot acceptance of the concept of yaw augmentation were also evaluated. Eight highly qualified instructor pilots were used as data collection pilots. These pilots flew profiles representing typical helicopter instrument maneuvers. Each maneuver, except for the instrument takeoff flown augmented only, was flown first with the yaw-augmentation system engaged and then repeated without yaw-augmentation. Objective and subjective data was obtained through the use of video audio, oscillograph recording equipment and in-flight and postflight questionnaires and debriefings. Due to the lack of large scale computer facilities for objective data analysis, an interim report is being published. A final report utilizing correlation and regression analysis documenting cause and effect relationships will be published when computer facilities are available. The present interim report provides limited objective data analysis and project personnel interpretation of the subjective data. Author (GRA)

N77-11068*# Bolt, Beranek, and Newman, Inc Cambridge, Mass

ACOUSTICAL EVALUATION OF THE NASA LANGLEY V/STOL WIND TUNNEL

Istvan L Ver [1976] 45 p refs

(Contract NAS1-9559)

(NASA-CR-145087, Rept-2288)

Avail NTIS

HC A05/MF A01 CSCL 20A

The results are presented of the acoustical measurements made to supply NASA Langley operating personnel with the acoustical characteristics of the tunnel test section needed for the planning of acoustical measurements and to identify the major noise sources. The results of the preliminary measurements of the spatial distribution of the sound field in the closed tunnel configuration indicate that the total sound power output of an unknown sound source placed in the test section could most probably be evaluated by measuring the sound pressure in two properly chosen locations in the duct - one upstream and one downstream of the test section. However, it is recommended that the practicability of this method of sound power output measurements be further investigated, preferably in a small scale model of the V/STOL Tunnel. Author

N77-11107*# McDonnell Aircraft Co St Louis Mo
GROUND TEST OF THE D SHAPED VENTED THRUST VECTORING NOZZLE

D W Esker 15 Oct 1976 83 p refs

(Contract NAS2-8663)

(NASA-CR-137959 MDC-A4434)

Avail NTIS

HC A05/MF A01 CSCL 21H

Static ground tests of a large scale lift/cruise thrust vectoring nozzle were conducted to establish (1) vectoring performance 'in and out of ground effect (2) thrust spoilage capability (3) compatibility of the nozzle with a turbotip fan, and (4) the nozzle structural temperature distribution. Vectoring performance of a short coupled vented nozzle design on a large scale (60%) basis was compared with small scale (4.5%) test nozzle results. The test nozzle was a 'boilerplate' model of the MCAIR D vented nozzle configured for operation with the LF336/J85 turbotip lift fan system. Calibration of the LF336/J85 test fan with a simple convergent nozzle was performed with four different nozzle exit areas to establish reference thrust nozzle pressure ratio and nozzle corrected flow characteristics for comparison with the thrust vectoring nozzle data. Thrust vectoring tests with the D vented nozzle were conducted over the range of vector angles between 0 and 117 deg for several different nozzle exit areas. Author

N77-11111*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif
CONFERENCE ON THE DEVELOPMENT OF FIRE-RESISTANT AIRCRAFT PASSENGER SEATS

Larry L Fewell Demetrius A Kourides, Robert W Rosser, and John A Parker Aug 1976 130 p refs Conf held at Moffett Field Calif, 19 Mar 1976

(NASA-TM-X-73144 A-6633) Avail NTIS HC A07/MF A01 CSCL 06K

Papers are presented dealing with the development of aircraft seats with the minimum fire risk. Criteria examined include flame spread, heat release, and smoke and/or toxic fumes. Materials and performance specifications of all seat material options are provided. Author

N77-11122# Royal Netherlands Aircraft Factories Fokker Schiphol-Oost

CERTIFICATION OF THE REPLACEMENT OF GLASS FABRIC PER MAT SPEC 5670/1, WITH GLASS FABRIC PER MAT SPEC 5670 IN THE F27 PLASTIC SANDWICH WING-AND-STABILIZER-LEADING EDGES

L M Godfried 12 May 1975 11 p

(FOK-R-1876) Avail NTIS HC A02/MF A01

The mechanical properties of sandwich constructions for F27 leading edges provided with faces of different glass fabric combinations were investigated. Three-point bending tests were carried out on sandwiches built up with glass fabric. No significant difference was found in mechanical strength and stiffness between the sandwiches tested. Author (ESA)

N77-11186# Service Technique de l'Aeronautique Paris (France) Section Armements Missiles

MILITARY ROCKET AIRCRAFT INHERENT CONSTRAINTS AND THEIR USES [LES ROQUETTES D'AVIATION CONTRAINTES INHERENTES A LEUR UTILISATION]

Claude Sengeissen In AGARD Small Solid Propellant Rockets for Field Use Sep 1976 7 p In FRENCH (For primary document see N77-11185 02-28)

Avail NTIS HC A06/MF A01

The capabilities and disadvantages of aircraft launched self-propelled rockets are discussed. Transl by A H

N77-11198*# Jet Propulsion Lab, Calif Inst of Tech Pasadena
REDUCTION OF GASEOUS POLLUTANT EMISSIONS FROM GAS TURBINE COMBUSTORS USING HYDROGEN-ENRICHED JET FUEL Progress Report

Richard M Clayton 15 Oct 1976 58 p refs

(Contract NAS7-100)

(NASA-CR-149146 JPL-TM-33-790)

Avail NTIS

HC A04/MF A01 CSCL 21D

Recent progress in an evaluation of the applicability of the hydrogen enrichment concept to achieve ultralow gaseous pollutant emission from gas turbine combustion systems is described. The target emission indexes for the program are 1.0 for oxides of nitrogen and carbon monoxide, and 0.5 for unburned hydrocarbons. The basic concept utilizes premixed molecular hydrogen, conventional jet fuel and air to depress the lean flammability limit of the mixed fuel. This is shown to permit very lean combustion with its low NOx production while simultaneously providing an increased flame stability margin with which to maintain low CO and HC emission. Experimental emission characteristics and selected analytical results are presented for a cylindrical research combustor designed for operation with inlet-air state conditions typical for a 30:1 compression ratio, high bypass ratio turbofan commercial engine. Author

N77-11207# Applied Systems Corp Vienna Va
THE PRODUCTION AND REFINING OF CRUDE OIL INTO MILITARY FUELS Final Report

Herbert Bartick Kumar Kunchal Duane Switzer Robert Bowen and Rita Edwards Aug 1975 215 p refs

(Contract N00014-75-C-0055)

(AD-A024652) Avail NTIS HC A10/MF A01 CSCL 21/4

The technical objectives of the program were to demonstrate that a wide spectrum of military operational fuels derived from shale oil crude could be obtained in a commercial industrial facility with minimum or minor modification, and to incentivize industry in oil shale development and technology. Shale oil crude was processed into gasoline, heavy fuel oil, and JP-4 in small laboratory quantities in the United States by the Bureau of Mines (ERDA) and private industry. However, no large scale commercial refining of the shale oil crude into a wide variety of products had been attempted up until this program. The various fuels produced met a majority of the military federal and commercial specifications requirements. However, these fuels tended to exhibit storage and thermal instabilities. In addition, the fuels contained a high wax content, high particulate matter, and high gum content. It is concluded that it is feasible to obtain military and civilian operational fuels from shale oil crude using a commercial refinery. However, additional effort has to be extended to overcome some refinery and operational problems to obtain maximum yields and improved properties. GRA

N77-11345*# United Technologies Research Center, East Hartford, Conn

THE INVISCID PRESSURE FIELD ON THE TIP OF A SEMI-INFINITE WING AND ITS APPLICATION TO THE FORMATION OF A TIP VORTEX Final Report

G F Hall S J Shamroth H McDonald, and W R Briley
Washington NASA Oct 1976 84 p refs
(Contract NAS1-12794)

(NASA-CR-2748, Rept-36 300) Avail NTIS HC A05/MF A01 CSCL 01A

A method was developed for determining the aerodynamic loads on the tip of an infinitely thin, swept, cambered semi-infinite wing at an angle of attack which is operating subsonically in an inviscid medium and is subjected to a sinusoidal gust. Under the assumption of linearized aerodynamics the loads on the tip are obtained by superposition of the steady aerodynamic results for angle of attack and camber, and the unsteady results for the response to the sinusoidal gust. The near field disturbance pressures in the fluid surrounding the tip are obtained by assuming a dipole representation for the loading on the tip and calculating the pressures accordingly. The near field pressures are used to drive a reduced form of the Navier-Stokes equations which yield the tip vortex formation. The combined viscid-inviscid analysis is applied to determining the pressures and examining the vortex rollup in the vicinity of an unswept, uncambered wing moving steadily at a Mach number of 0.2 at an angle of attack of 0.1 rad. The viscous tip flow calculation shows features expected in the tip flow such as the qualitatively proper development of boundary layers on both the upper and lower airfoil surfaces. In addition, application of the viscous solution leads to the generation of a circular type flow pattern above the airfoil suction surface.

Author

N77-11356# Naval Ship Research and Development Center
Bethesda Md Aviation and Surface Effects Dept

ANALYSIS AND DESIGN OF EJECTOR DIFFUSER FOR OPTIMUM THRUST

Tsze C Tai Mar 1976 29 p refs Presented at Navy Symp on Aeroballistics (10th) Fredericksburg Va, 15-17 Jul 1975 (AD-A025491, AERO-1214) Avail NTIS HC A03/MF A01 CSCL 21/5

Recent advances in jet ejectors operating under static conditions have produced high thrust augmentation that is feasible for application to V/STOL flight. However because of (a) loss in augmentation in duct flow (b) ramjet effect and (c) space limitations high performance and compactness are required in the design of thrust-augmenting ejectors for V/STOL aircraft. An analytical inverse approach is presented in which the pressure distribution along the diffuser wall of an ejector is defined for a given entrance flow condition and the contour of the desired diffuser wall is determined by using a finite difference technique. The prescribed pressure distribution is first optimized by a modified Stratford criterion for incipient separation of turbulent boundary layers. This optimization makes it applicable to compressible two-dimensional and axisymmetric flows.

GRA

N77-11365*# California Univ., Los Angeles Mechanics and Structures Dept

HOLOGRAPHIC FLOW VISUALIZATION Final Report

A F Charwat and M E Fournay Nov 1976 47 p refs
(Grant NsG-268)

(NASA-CR-149182 UCLA-ENG-76105) Avail NTIS HC A03/MF A01 CSCL 14E

Holographic visualization techniques are presented of the vortex wake of a lifting wing. The motions of tracer particles in vortical flows are described along with the development of a liquid-drop tracer generator. An analysis is presented of the motion of particles of arbitrary density and size in solid body and potential vortex flows.

M C F

N77-11404*# Army Aviation Systems Command St Louis, Mo

BEARING RESTORATION BY GRINDING

Heinz Hanau R J Parker, E V Zaretsky S M Chen and Hubert L Bull 21 May 1976 94 p refs Presented at joint Army-NASA Seminar, St Louis 20-21 May 1976 Sponsored by NASA

(NASA-CR-149188 AD-A025420 USAAVSCOM-TR-76-27) Avail NTIS HC A05/MF A01 CSCL 01/3

A joint program was undertaken by the NASA Lewis Research Center and the Army Aviation Systems Command to restore by grinding those rolling-element bearings which are currently being discarded at aircraft engine and transmission overhaul. Three bearing types were selected from the UH-1 helicopter engine (T-53) and transmission for the pilot program. No bearing failures occurred related to the restoration by grinding process. The risk and cost of a bearing restoration by grinding programs was analyzed. A microeconomic impact analysis was performed.

GRA

N77-11405# Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost

RESEARCH ON ADHESIVE BONDING AND SURFACE CHARACTERISTICS OF METALS AT FOKKER-VFW

R J Schliekelmann 16 Sep 1974 18 p refs
(FOK-R-1816) Avail NTIS HC A02/MF A01

Background information is given about the research work that has been carried out on various aspects of the strength and durability of adhesive bonded joints for aerospace applications. That work includes studies on the relation between surface characteristics of metals and the durability of adhesion and corrosion resistance of bonded joints, the research and development on innovative nondestructive adhesion and cohesion testing methods, and adhesion characteristics of esterol resistant paints. The capabilities in this field of the Fokker-VFW Technological Center at Schiphol the Netherlands are given.

Author (ESA)

N77-11411# National Research Council of Canada, Ottawa (Ontario) Div of Mechanical Engineering

THE ROTATING STATOR CONCEPT EXPERIMENTAL PERFORMANCE CHARACTERISTICS COMPARED WITH THE CONVENTIONAL COMPRESSOR

M S Chappell D A J Millar and A A Swiderski Jul 1975 66 p refs

(AD-A024465, DME-ME-242 NRC-1915032) Avail NTIS HC A04/MF A01 CSCL 21/5

The Small Compressor Research Program is a co-operative project between the National Research Council of Canada (NRC) and Rolls Royce (Canada) Limited (RR). Its objectives are to investigate both analytically and experimentally, the Fanstat concept of compressor spooling. This concept involves the co-rotation of both rotor and stator rows of a compressor in the core engine with the fan being mounted on, and driven by the rotating stator case. The primary function of the fan and stat is to provide an aerodynamic gearbox that will permit the fan and the fan turbine to run close to their individual optimum speeds so overcoming the mismatch in blade speeds inherent in direct-coupled fan-turbine spools of high-bypass ratio turbofan engines. Previous reports have described preliminary experimental calibrations of the conventional three-stage axial compressor from which the Fanstat compressor was derived and a hybrid-computer model of the rotating stator compressor test rig. The current report describes a more-detailed calibration of this conventional compressor and presents the performance characteristics of the co-rotating compressor configuration. The test results confirmed aerodynamic feasibility of the Fanstat arrangement of compressor spooling and major performance parameters were not significantly different from the compressor in the useful operating region. Flow range and surge behavior of the co-rotating compressor were examined and although somewhat unusual at various speeds did not indicate any serious limitations on the applicability of the concept.

GRA

N77-11412# North Carolina State Univ., Raleigh Engineering Design Center

TRANSIENTS IN TURBOCOMPRESSORS Final Report, Jan 1975 - Feb 1976

J N Perkins, L W Hardin F O Carta (United Technol Res Center, East Hartford Conn) and W C Griffith Feb 1976 49 p refs

(Grant AF-AFOSR-2802-75, AF Proj 9781)

(AD-A024275 EDC-76-1 AFOSR-76-0501TR) Avail NTIS HC A03/MF A01 CSCL 21/5

This report describes the work done between the Spring of 1975 and February 1976 on a cooperative program between North Carolina State University and the United Technologies Research Center. The effect of unsteady flow on compressor performance is being investigated experimentally in the UTRC Large Scale Rotating Rig and theoretically at NCSU with a refined computer-based flow model. The goal of the program is to provide improved predictive techniques for use in turbocompressor design based upon an improved understanding of the basic coupling between distorted inlet flow, the onset and disappearance of rotating stall, and compressor stage performance. The diameter is 5 ft with the maximum rotational speed of 600 rpm. The blade chord of 6 in coupled with an inlet velocity of 100 ft/sec gives a blade RE approx 0.000005. Upstream screens provide a 20% sinusoidal variation in axial velocity once per revolution. Rotating instrumentation will measure steady and unsteady surface pressures on the rotor blade, the boundary layer behavior on the blade, and will allow a complete investigation of the 3-D properties of the near wake of the rotor. Stationary frame measurements will include mean and transient inlet and downstream conditions. A 45 channel slipring assembly with on-board excitation and amplification electronics developed under this program will give high quality signals on 18 transient data channels. A refined theoretical flow model has been developed at NCSU for use in data interpretation with runs planned for early spring. The program is continuing under a follow-on contract with the AFOSR. Author (GRA)

N77-11441# Schweizerischer Verband fuer die Materialpruefung der Technik (SVMT) Duebendorf (Switzerland)

MECHANISM OF MATERIAL FATIGUE DURING THE CRACK INITIATION STAGE [ZUM MECHANISMUS DER MATERIALERMUEDUNG IM VOR-RISS-STADIUM]

J Branger and E Steinheil 1976 19 p refs In GERMAN (ICAF-DOC-895) Avail NTIS HC A02/MF A01

Full scale fatigue tests by fatigue-history loading were performed with the aim to fly military A/C up to the limit of their structural capacity and to extend the service life by statistical fatigue tests of a critical safe-life element. The first analyses of fatigued light alloy specimens revealed in surface layers down to about 30 nm concentrations of metal hydroxides increasing with increasing fatigue straining. Similar concentrations were analyzed in steel specimens. Author

N77-11445# Laboratorium fuer Betriebsfestigkeit Darmstadt (West Germany)

APPLICATION OF DESIGN DATA DERIVED FROM FATIGUE TESTS WITH SERVICE-LIKE LOAD SEQUENCES FOR LIFE PREDICTION

D Schuetz and H Lowak 16 Feb 1976 61 p refs In GERMAN ENGLISH summary Sponsored by Bundesmin fuer Verteidigung

(LBF-FB-109/76) Avail NTIS HC A04/MF A01 Lab fuer Betriebsfestigkeit Darmstadt West Ger DM 38

Reliable life curves were established for a load sequence and a cumulative frequency distribution which are typical at the wing structure of transport aircraft. The life estimation for details subjected to load spectra varying from that applied to the specimens were demonstrated using the Relative Miner's rule. It was found that for large differences between the test load and the design load spectra the Relative Miner's rule is not advantageous. As the difference between the estimated life based

on the Relative Miner's rule and the corresponding tests results could to a large extent be explained by the action of residual stresses a suitable correction was introduced. The correction was applied to the specimens of this investigation using empirically derived data. The results proved an effective refinement of the Relative Miner's rule leading to very accurate life predictions.

Author (ESA)

N77-11447# Laboratorium fuer Betriebsfestigkeit Darmstadt (West Germany)

COMPILATION OF MEASURES TO INCREASE THE FATIGUE STRENGTH OF AIRCRAFT STRUCTURES

D Schuetz and J J Gerharz 5 Nov 1975 96 p refs In GERMAN ENGLISH summary

(LBF-TB-126/75) Avail NTIS HC A05/MF A01 Lab fuer Betriebsfestigkeit Darmstadt West Ger DM 42

The compilation is the result of a literature survey and was made to comprehensively inform the designer and to facilitate the selection of suitable measures for a fatigue critical structural detail. Together with the description of the measures, improvement factors are presented which should be used only as lead values. A total of 40 compilations of structures such as eye rods, open holes, and riveted screw joints are presented.

Author (ESA)

N77-11449# Royal Netherlands Aircraft Factories Fokker Schiphol Oost

FRACTURE TOUGHNESS OF 8mm 2024-T3 NON CLAD PLATE WITH LONG CENTRAL CRACKS

A H LaCroix 2 Jun 1975 9 p

(FOK-R-1879) Avail NTIS HC A02/MF A01

Fracture toughness tests were carried out with center notched specimens of 8 mm 2024-T3 non clad plate to predict the fail safe properties of laminated airbus links. A K-value (fracture toughness) of 142 kgf x mm to the 3/2th power was established using the Feddersen method. The Feddersen method for presenting fracture toughness test results is briefly described. ESA

N77-11450# National Aerospace Lab., Amsterdam (Netherlands) Structures and Materials Div

CALCULATION OF VIBRATION MODES AND RESONANCE FREQUENCIES OF THE NORTHROP NF-5

H H Ottens 15 Apr 1975 71 p refs Supersedes NLR-TR-74012-U. Sponsored by Directorate of Mater Air RNLAf

(NLR-TR-75050-U NLR-TR-74012-U) Avail NTIS HC A04/MF A01

A calculation of global values of resonance frequencies, vibration modes, and generalized masses was made for the Northrop NF-5 in order to investigate the potentialities of both the finite element method and the component mode method in obtaining these characteristics. The configurations considered involve full tip tanks, 70 lbs stores at the outboard pylons, full or empty 275 USG tanks at the inboard pylons, and a 150 USG tank at the center line pylon. For these configurations a comparison was made with ground vibration test results. ESA

N77-11478# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio

CURRENT PRACTICE ON ESTIMATING CRACK GROWTH DAMAGE ACCUMULATION WITH SPECIFIC APPLICATION TO STRUCTURAL SAFETY DURABILITY AND RELIABILITY Final Report, 15 Jan - 15 Mar 1975

Howard A Wood, Joseph Gallagher, Robert M Engle, and John M Potter Jan 1976 67 p refs

(AF Proj 1367)

(AD-A025499, AFFDL-TR-75-32)

Avail NTIS

HC A04/MF A01 CSCL 11/6

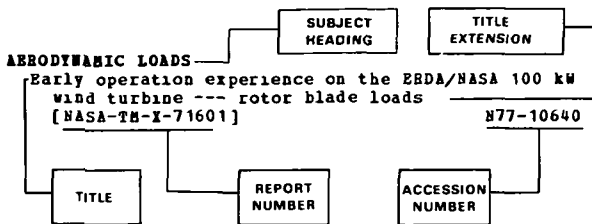
This report provides a brief summary of current practice on predicting crack growth damage accumulation with specific applications to current USAF policies on Safety and Durability. Analytical procedures are required to determine safe crack growth-life intervals and to estimate economic limits of crack growth. Reliability and risk analyses are discussed to illustrate their impact on structural decisions. The life prediction methodology will be examined to illustrate the major effects of the structural parameters (geometry), the material parameters (basic crack growth rate) and loading (usage patterns). Examples are cited to give indication of confidence in making life predictions. A summary of procedures for estimating service loads and chemical-thermal environments is included as they relate to simulating usage effects in the laboratory. GRA

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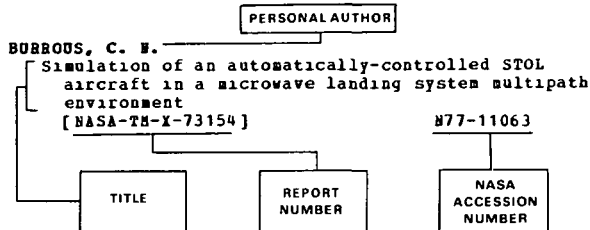
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